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ENVIRONMENTAL EFFECTS OF DREDGING PROGRAM

TECHNICAL REPORT D-88-8

# INLAND WATERWAYS: PROCEEDINGS OF A NATIONAL WORKSHOP ON THE BENEFICIAL USES OF DREDGED MATERIAL

27-30 October 1987, St. Paul, Minnesota

Hosted by

US Army Engineer District, St. Paul

Mary C. Landin, Editor

US ARMY ENGINEER WATERWAYS EXPERIMENT STATION

November 1988

Final Report





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A national workshop featuring beneficial uses of dredged material in inland waterway systems of the US was held in St. Paul, MN, on 27-30 October 1987. Participating agencies included the US Army Corps of Engineers, the US Fish and Wildlife Service, the USDA Soil Conservation Service, Environment Canada, and numerous other state regulatory, resource, and transportation agencies. Attendees from North and Central America met for three days of technical papers and panel discussions. The workshop was introduced by a day-long field trip down the Mississippi River from St. Paul to Weaver Bottoms in the Upper Mississippi River National Wildlife and Fish Refuge at Winona, MN, to numerous showcased beneficial use sites.

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Agency and industry overviews in panels were given on the first day of papers. Technical sessions on aquatic habitats; habitat development case studies; innovative uses and concepts; recreation, commercial, and industrial applications; and the Great Lakes and their unique opportunities for beneficial use applications were held. Attendees also met in informal breakout sessions to discuss the direction each technical area should be taking and to make recommendations for development of each topic within inland waterways. The workshop was moderated by Dr. Laurence R. Jahn, President of the Wildlife Management Institute in Washington, DC. Keynote addresses were given by Deputy Assistant Secretary of the Army (Civil Works) John S. Doyle and BG Peter J. Offringa, Deputy Director for Civil Works, CE, both of Washington, DC.

Overall workshop recommendations included: (a) to continue to hold timely, informative workshops on beneficial uses in various parts of the US, with the next one located on the west coast featuring coastal and marine environments; (b) to strive for maximum cooperation and communication between agencies and groups, including the formation of interagency working groups at the CE District level; (c) to work more closely with cost-sharing project sponsors to assist them in finding means to solve their erosion or stabilization and material placement problems in a cost-effective manner; (d) to encourage the development of long-term management strategies for dredging that incorporate both engineering and environmental realities; (e) to work harder to inform the general public on the positive aspects of using placement sites productively; (f) to develop both formal and informal working agreements among agencies and groups to better accomplish the CE dredging mission; and (g) to continue to seek better means of dredging and placement and innovative uses of dredged material in inland waterway systems.



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## PREFACE

The National Workshop on the Beneficial Uses of Dredged Material in Inland Waterways was sponsored and funded by the Dredging Division, Office, Chief of Engineers (CE), US Army. This is the second national workshop on beneficial uses and the first such workshop on inland waterways. As such, the proceedings will be an important contribution to the engineering and scientific communities. Work was conducted through the Environmental Effects of Dredging Program (EEDP) at the US Army Engineer Waterways Experiment Station (WES). Participating agencies included the US Fish and Wildlife Service (FWS), the US Environmental Protection Agency (EPA), the US Department of Agriculture Soil Conservation Service (SCS), Environment Canada, and numerous State agencies with responsibilities for water resources, regulation, and transportation. Technical assistance and logistical support were provided by the US Army Engineer District, St. Paul (the host District) and by the FWS.

Proceedings editor and compiler was Dr. Mary C. Landin of the Wetland and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), WES, who also provided overall coordination for the workshop. Mr. Bobby Odom, Information Technology Laboratory, under the Inter-Governmental Personnel Act, provided editorial review.

Members of the Coordinating and Planning Committee were Messrs. William Goetz, Harold Taggatz, and Robert Whiting, all of the St. Paul District, St. Paul, Minnesota; Mr. David C. Cowgill, US Army Engineer Division, North Central, Chicago, Illinois; Mr. David B. Mathis, Dredging Division, CE, Washington, DC; and Mr. Thomas R. Patin and Dr. Landin, WES, Vicksburg, Mississippi. The workshop was moderated by Dr. Laurence R. Jahn, President, The Wildlife Management Institute, Washington, DC. Technical session coordinators were Messrs. William R. Murden, Chief, Dredging Division, CE, Washington, DC; Harry N. Cook, President, National Waterways Conference, Washington, DC; Robert Barber, EPA, Kansas City, Missouri; Bruce Stebbings, FWS, Marion, Illinois; Charles R. Terrell, National Water Quality Specialist, SCS, Washington, DC; M. William Newstrand, Director of Ports of Waterways, Minnesota Department of Transportation, St. Paul, Minnesota; George W. Johnson, Jr., US Army Engineer Division, Southwestern, Dallas, Texas; David C. Cowgill, US Army Engineer Division, North Central, Chicago, Illinois; and

Robert L. Lazor, Hollis H. Allen, Thomas R. Patin, and H. Roger Hamilton, all of WES.

The workshop and the compilation of the proceedings were conducted under the general supervision of Dr. Hanley K. Smith and Mr. Ellis J. Clairain, Jr., Chiefs, WTHG; Dr. Conrad J. Kirby, Chief, Environmental Resources Division (ERD), EL; Mr. H. Roger Hamilton, Acting Chief, ERD; Dr. Robert M. Engler, Program Manager, EEDP. Chief of EL was Dr. John Harrison.

Coordination and technical assistance at the workshop were provided by LTC David M. Nelson, Deputy District Engineer, and Messrs. Robert Whiting, William Goetz, Harold Taggatz, Dennis Anderson, Daniel Krumholz, Marc Krumholz, all of the St. Paul CE District. Workshop support staff were Ms. Billie Skinner, WES, who was also responsible for taping the proceedings; Ms. Jan Pream, Mary Kay Linder, Mickey Ekstrand, and Denise Yale, and Messrs. Bob Mike and William Hutchenson, all of the St. Paul CE District. Mr. Richard Berry, Manager, Upper Mississippi River National Wildlife Refuge, Winona, Minnesota, and his staff gave an overview of and provided assistance for the workshop field trip.

LTG Henry J. Hatch is the Chief of Engineers and former Director of Civil Works, US Army, Washington, DC. COL Dwayne G. Lee, EN, is Commander and Director of WES, and Dr. Robert W. Whalin is Technical Director. COL Joseph Briggs, EN, is District Engineer, St. Paul.

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ATTENDEES (Continued)

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THOMPSON, James, Memphis CE District, Clifford Davis Federal Building, Memphis, TN (FTS 222-3231)

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VANDER ELS, BG Theodore, Commander, North Central CE Division, 536 Clark Street, Chicago, IL 60605

VARNER, Edward L., Jr., Mobile CE District, Black Warrior River Road, 101 21st Avenue, Tuscaloosa, AL 35401-1015 (205/752-3571)

ATTENDEES (Continued)

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WALSH, James E., Bay State Environmental Consultants, 39 Maple Street, East Longmeadow, MA 01028 (413/525-3822)

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YANCEY, Thomas N., Jr., Norfolk CE District, 803 Front Street, Norfolk, VA 23510 (804/441-3775)

YURDIN, Bruce, Illinois Environmental Protection Agency, 2200 Churchill Road, Springfield, IL 62706 (217/782-1696)

## AGENDA

INLAND WATERWAYS: PROCEEDINGS OF A NATIONAL WORKSHOP ON THE BENEFICIAL USES OF DREDGED MATERIAL

27-30 October 1987, St. Paul, Minnesota
Holiday Inn Town Square

27 October 1987

| | |
|---|---|
| 0845-1730 | FIELD TRIP: Bus and boat tour of the Weaver Bottoms habitat field site and other points of interest on the Upper Mississippi River where beneficial uses of dredged material have been applied. The tour will begin with a briefing at 0845 at the workshop hotel, and attendees will board tour buses, with guides, to drive along the Mississippi River banks to the site. Attendees will travel down the Minnesota side of the river and back to St. Paul on the Wisconsin side, with stops along the route. A boat tour of Weaver Bottoms and other beneficial use sites is included---Messrs. Robert Whiting, Daniel Krumholz, Marc Krumholz, and Dennis Anderson, St. Paul Corps of Engineer (CE) District, St. Paul, MN, and Fountain City, WI, and Mr. Richard Berry, US Fish and Wildlife Service, Winona, MN |
| 1800-1930 | Reception |

28 October 1987

| | |
|---|---|
| 0800-0805 | Call to Order---Dr. Laurence R. Jahn, President, Wildlife Management Institute, Washington, DC, Workshop Moderator |
| 0805-0820 | Welcome and Opening Comments---LTC David M. Nelson, Deputy Commander, St. Paul CE District, St. Paul, MN; and BG Theodore Vander Els, Commander, North Central CE Division, Chicago, IL |
| 0820-0845 | Workshop Introductory Remarks---Dr. Jahn |
| 0845-0915 | Keynote Address---The Honorable John S. Doyle, Jr., Acting Assistant Secretary of the Army (Civil Works), Washington, DC |
| 0915-0930 | BREAK |
| 0930-1130 | Federal Agency Viewpoints Panel |
| | Mr. William R. Murden, Chief, Dredging Division, US Army Corps of Engineers, Fort Belvoir, VA, Panel Chairman |
| | Mr. Richard C. Nelson, Supervisor, Rock Island Field Office, US Fish and Wildlife Service, Rock Island, IL |

Dr. Marc Tuchman, Office of Water Quality, Region V, US Environmental Protection Agency, Chicago, IL

Dr. Robert J. Glennon, National Plant Materials Center, USDA Soil Conservation Service, Beltsville, MD

1130-1300 LUNCH

1300-1500 Non-Federal Interests and Viewpoints: A Panel

Mr. Harry N. Cook, President, National Waterways Conference, Washington, DC, Panel Chairman

Mr. Donald C. McCrory, Memphis and Shelby County Port Commission, Memphis, TN

Mr. Richard S. Bartz, Division of Water, Ohio Department of Natural Resources, Columbus, OH

Mr. Daniel A. Injerd, Division of Water Resources, Illinois Department of Transportation, Chicago, IL

Dr. Paul Hill, Director's Office of Regulatory Affairs, West Virginia Department of Natural Resources, Charleston, WV

1500-1515 BREAK

1515-1715 First Technical Session: Aquatic Habitats

Session Co-Chairmen---Mr. Robert Barber, US Environmental Protection Agency, Kansas City, MO; and Mr. Robert L. Lazor, Waterways Experiment Station, CE, Vicksburg, MS

An Overview of Uses of Dredged Material to Improve or Create Aquatic Habitat in Inland Waterways---Dr. Andrew C. Miller, Waterways Experiment Station, CE, Vicksburg, MS

Aquatic Habitat Development on the Tombigbee River, Alabama---Dr. Andrew C. Miller and Mr. K. Jack Kilgore, Waterways Experiment Station, Vicksburg, CE, MS; Dr. Robert King, Central Michigan University, Mt. Pleasant, MI; and Mr. Jack Mallory, Mobile CE District, Mobile, AL

Aquatic Habitat Creation on the Ohio River, with Regulatory Considerations---Dr. Andrew C. Miller, Waterways Experiment Station, CE, Vicksburg, MS; Mr. Bruce Stebbings, US Fish and Wildlife Service, Marion, IL; and Mr. Robert Kanzinger, Louisville CE District, Louisville, KY

Results of Salmonid Fish Habitat Restoration with Dredged Material in the Campbell River Estuary, British Columbia, Canada---Dr. Colin Levings, West Vancouver Laboratory, Department of Fisheries and Oceans, Vancouver, British Columbia, Canada

Littoral Zone Aquatic Habitat Studies with Dredged Material at Lake of the Woods, Northwestern Minnesota---Mr. Daniel Wilcox, St. Paul CE District, St. Paul, MN

1930-2130 DINNER. Guest Speaker: BG Peter J. Offringa, Deputy Director for Civil Works, US Army Corps of Engineers, Washington, DC

29 October 1987

0800-1000 Second Technical Session: Habitat Development Case Studies

Session Co-Chairmen: Mr. Bruce Stebbings, US Fish and Wildlife Service, Marion, IL; and Mr. Hollis H. Allen, Waterways Experiment Station, CE, Vicksburg, MS

Upland Habitat Development on Dredged Material Disposal Sites: Upper Mississippi River---Mr. Jon R. Duyvejonck, Rock Island CE District, Rock Island, IL

Wetland and Upland Wildlife Habitat Development on Dredged Material Disposal Areas on the Tennessee-Tombigbee Waterway---Mr. Danny R. Hartley, Columbus Area Office, Mobile CE District, Columbus, MS

Habitat Management of Interior Least Terns: Problems and Opportunities in Inland Waterways---Messrs. John W. Smith and Norman P. Stucky, Missouri Department of Conservation, Columbia, MO

Establishment of a Native Midwestern Wetland Plant Community through Relocation of Marsh Topsoil---Ms. Sue Elston and Mr. John Rogner, Chicago CE District, Chicago, IL; Dr. Gerould S. Wilhelm, Morton Arboretum, Lisle, IL; and Mr. Wayne Lampa, Forest Preserve District of DuPage County, Glenn Ellyn, IL

1000-1015 BREAK

1015-1215 Third Technical Session: Innovative Beneficial Uses and Concepts

Session Chairman: Mr. Charles R. Terrell, Office of Water Quality, USDA Soil Conservation Service, Washington, DC; and Mr. Thomas R. Patin, Environmental Effects of Dredging Program (DOTS), Waterways Experiment Station, CE, Vicksburg, MS

Reclamation of Pyrite Mine Spoil Using Dredged Material---Dr. Gerould S. Wilhelm, Morton Arboretum, Lisle, IL; Dr. John W. Simmers and Mr. Richard G. Rhett, Waterways Experiment Station, CE, Vicksburg, MS; and Dr. J. M. Marquenie, Division of Technologie for Society, Den Helder, The Netherlands

Beneficial Uses of Dredged Material in Seven New England Projects---Messrs. James E. Walsh, Carlos Carranzat, and Robert A. Humphrey, Bay State Environmental Consultants, East Longmeadow, MA

Beneficial Uses from Dredged Lake Sediments in Illinois---Dr. William P. Fitzpatrick, Illinois Department of Energy and Natural Resources, Champaign, IL; and Dr. Glenn E. Stout, Water Resources Center, University of Illinois, Urbana, IL

The Upper Mississippi River Channel Maintenance Plan: Beneficial and Productive Use of the Dredged Material---Mr. Daniel J. Krumholz, St. Paul CE District, Fountain City, WI

1215-1330 LUNCH

1330-1530 Fourth Technical Session: Recreation, Commercial, and Industrial Beneficial Use Applications

Session Co-Chairmen: Mr. George W. Johnson, Jr., Southwestern CE Division, Dallas, TX; and Mr. Roger Hamilton, Waterways Experiment Station, CE, Vicksburg, MS

Innovative Recreation and Commercial Uses of Dredged Material on the Tennessee-Tombigbee Waterway---Mr. Nathaniel D. McClure IV, Mobile CE District, Mobile, AL

Commercial and Industrial Uses of Dredged Material in the Memphis Area of the Lower Mississippi River---COL Marvin L. Jacobs (US Army, Ret.), Center for River Studies, Memphis State University, Memphis, TN.

Development of Project Lands for Port and Industrial Use with Regard to Wildlife Mitigation---Dr. Michael F. Passmore, Walla Walla CE District, Walla Walla, WA

An Overview of Dredged Material Management in the Vicksburg District---Mr. E. Gaylan McGregor, Vicksburg CE District, Vicksburg, MS

1530-1545 BREAK

1545-1745 Fifth Technical Session: The Great Lakes and Their Unique Opportunities for Beneficial Use Applications of Dredged Material

Session Co-Chairmen: Mr. M. William Newstrand, Director of Ports and Waterways, Minnesota Department of Transportation, St. Paul, MN; and Mr. David C. Cowgill, North Central CE Division, Chicago, IL

An Overview of Past and Potential Natural Resource Beneficial Uses of Dredged Material in the Great Lakes---Dr. Mary C. Landin, Waterways Experiment Station, CE, Vicksburg, MS

A View from Wisconsin on the Beneficial Uses of Dredged Material---Mr. P. Scott Hausmann, Wisconsin Department of Natural Resources, Madison, WI

A View from Michigan on the Beneficial Uses of Dredged Material---Mr. Daniel H. Morgan, DNR Liaison to the US Army Corps of Engineers, Michigan Department of Natural Resources, Lansing, MI

An Overview of Alternatives for Toledo Harbor, Focusing on Commercial, Agricultural, and Upland Reuse---Mr. Edwin J. Hammett, Toledo Metropolitan Council of Governments; and Mr. John Hull, Hull and Associates Inc., Toledo, OH

Beneficial Uses of Dredged Material in the Development of Toronto Harbour---Mr. Ian Orchard, Office of Environmental Protection, Environment Canada, Toronto, Ontario, Canada

1900-2100 Informal Breakout Groups:

Aquatic Habitats
Habitat Development Case Studies
Innovative Uses and Concepts
Recreational, Commercial, and Industrial Applications
The Great Lakes and Their Unique Opportunities

30 October 1987

0820-0830 Greetings from the Western Dredging Association---Mr. Eric H. Seagren, Ellicott Machine Corporation, St. Louis, MO

0830-1000 Reports and Recommendations from Technical Sessions and Discussion Groups---session chairpersons/coordinators

1000-1015 BREAK

1015-1115 Conclusions and Observations: Where Do We Go From Here?

Mr. David B. Mathis, US Army Corps of Engineers, Washington, DC

Mr. John Wolflin, Supervisor, Boise Field Office, US Fish and Wildlife Service, Boise, ID

Mr. John W. Smith, Missouri Department of Conservation,

Dr. Laurence R. Jahn, Wildlife Management Institute, Washington, DC

1115-1145 General Discussion

1145-1200 Workshop Closing Remarks---Mr. Murden and Dr. Jahn

Coordinating and Planning Committee:

Mary Landin, Waterways Experiment Station, workshop coordinator William Goetz and Harold Taggatz, St. Paul District (Operations) Robert Whiting, St. Paul District (Planning), David Cowgill, North Central Division, Tom Patin, Waterways Experiment Station, Dredging Program (DOTS), David Mathis, CE, Dredging Division

# OPENING REMARKS

Laurence R. Jahn, President
The Wildlife Management Institute
Washington, DC
Workshop Moderator

It is a pleasure to call to order this important national workshop on the beneficial uses of dredged material in inland waterways. The Wildlife Management Institute has a long-standing working relationship with the Department of Defense on military lands and with the US Army Corps of Engineers (CE) on water development and management projects.

It has been delightful visiting with many of you again and being on the rewarding field trip yesterday. The dredged navigational channels and barge traffic should have reminded all of us of the importance of dredging to shipping commerce in this country and the world. The slip openings to provide small boats with access to side channels emphasized the sensitivity and imagination required in engineering designs to enhance hydrological conditions and to accommodate people's activities. Such multiple-benefiting plans and projects are needed in more areas. They are in the best interest of sound resource management and society---especially taxpayers.

When projects such as Weaver Bottoms are planned and implemented, with multiple purposes included, international, national, regional, and local dividends can be achieved as we witnessed yesterday. Responsibilities of the US and Canada, spelled out for migratory birds in international treaties and the North American Waterfowl Management Plan, can be met through well-designed projects. Remember, the beautiful swans, Canada geese, canvasbacks, mallards, and other migratory birds we observed rested on habitat provided through construction of the 9-ft navigation channel in the 1930's and improved management plans that 50 years later incorporated the birds' habitat needs. All of these helpful actions are occurring in the Upper Mississippi River National Wildlife and Fish Refuge Complex through a long-term commitment of the CE in handling dredged material. Plans and actions we heard about and accomplishments we saw yesterday are terribly important.

While it was easy for us to see from bus and boat the dividends from investments of taxpayer dollars in the river channel and its floodplain, our view was constrained from seeing overall land conditions in the watersheds which feed water, sediment, chemicals, and other materials into the Mississippi River. Regrettably, human activities in many of the nation's watersheds are resulting in excessive volumes of sediment being loosened, transported, and deposited in aquatic areas, including navigation channels. Thus, dredging seems like a never ending task, especially in the important water lanes of commerce and for other important waterborne activities.

Each of us engaged in management of natural resources must look broadly to problems in watersheds that compound what is happening in river systems. More than 75 percent of all US croplands are eroding at rates greater than soil loss tolerance levels at which sustained productivity is ensured.

Despite 50 years of soil conservation efforts, roughly two-thirds or 277 million acres of croplands require conservation treatment immediately to prevent further degradation. About 50 million acres are so highly erodible that they cannot be protected adequately without permanent retirement from intensive row crop production.

Aquatic sites receive massive volumes of inflowing sediment from degrading agricultural lands with much deposited in locations where dredging is essential to permit continuing navigational and associated activities. Our challenge as citizens as well as resource managers must be to come to grips much better with resolving problems of managing watersheds as well as river systems. They are intertwined.

Fortunately, some progress is being made to convert soil degrading agricultural land uses to sustainable uses. For example, about one-third or 97.6 million acres of all US croplands in 1986 were managed using some form of conservation tillage. In addition, up to 45 million acres of highly erodible lands are being removed from intensive row cropping through the conservation reserve. While this progress is heartening, much remains to be done to get soil losses within tolerable limits thereby reducing the volume of deposited sediments requiring dredging periodically.

It is this overall watershed/river system framework that is essential to keep in mind as we learn together at this timely workshop on how to achieve more benefits from dredged materials through integrated resource management.

Beneficial uses of dredged material have been of great interest to the CE for a number of years. William R. Murden, Chief of the CE Dredging Division, is on record stating that he would like to see one or more beneficial uses incorporated into every dredging project, although he realizes that this may not always be feasible.

The CE pioneered in collecting objective information on how to design projects to ensure dredged material is used to yield benefits of broad interest to society. Approximately $33 million was invested in studies over just five years (1973-1978). Prior to this, little was documented on impacts associated with dredging and disposal of dredged material. This undoubtedly was the world's largest such research effort ever conducted on dredging and use of dredged material. Important actions to ensure implementation of findings have followed.

In December 1986, MG Henry J. Hatch issued a policy letter on long-term management strategies for dredging and placing dredged material that fully embraces the concept of beneficial applications of dredged material. A helpful engineer manual (EM 1110-2-5026) on beneficial uses of dredged material was written at the Waterways Experiment Station (WES) in 1986. Nearly 3,000 copies have been distributed to date, both within and outside the CE. Some states such as Massachusetts have used information in the manual to strengthen their statutes and procedures for managing dredging and aquatic areas.

Also, in 1986, the first interagency workshop on the concept of beneficial uses of dredged material was held in Pensacola, FL. Proceedings have

been published at WES (TR D-87-1). Contributions of representatives from a variety of Federal and State agencies, as well as the private sector, are impressive. One of the major recommendations coming from this workshop was to continue to hold such informative meetings at a national level on a regular basis, perhaps every 12-18 months, in different regions of the nation.

Subsequently, a regional workshop on the beneficial uses of dredged material was held in the North Atlantic CE Division. Another is planned for April 1988 in the Southwestern CE Division. Proceedings of the North Atlantic workshop will be available in late 1987.

This national workshop addressing inland waterways and past, present, and potential beneficial applications of dredged material is another in the useful series of sessions recommended and planned. It is gratifying to see the broad spectrum of participants from the US, Canada, and elsewhere. Cooperative, coordinated efforts of many Federal, State, and Provincial agencies, as well as private interests, are crucial to handling dredged material in the best interest of the resource base and society. There are three major thrusts for this timely workshop:

1. To provide a forum for Federal and non-Federal agencies, State and local offices, and private and public groups such as port authorities and commissions, the dredging industry, and environmental action organizations to discuss beneficial uses as directly applied to inland waterways (including the Great Lakes).

2. To provide detailed information through panels and technical sessions on beneficial uses of dredged material in case studies and innovative applications and to explore the value of the concept to public/private sectors, as well as problems and opportunities associated with beneficial uses of dredged material.

3. To hear presentations on the new 1986 Water Resources Development Act, the CE's role in inland waterways with regard to dredging, regulatory actions, long-term management, interagency working groups, and other activities from Mr. John S. Doyle, Acting Assistant Secretary of the Army (Civil Works) and from BG Peter J. Offringa, Assistant Director for Civil Works, CE.

There is a full workshop agenda to respond to these purposes. To provide the time scheduled for each speaker or group of speakers, each spokesperson is requested to stay within the allotted time. Chairmen of individual sessions, as well as your moderator, will keep time. Your cooperation in holding to the agenda schedule will be welcomed and appreciated by everyone.

Announcements will be made at appropriate times throughout the workshop. Questions regarding the workshop will be handled by members of the CE Planning Committee, particularly Dr. Mary Landin, the workshop coordinator.

## KEYNOTE ADDRESS

## LOOKING AHEAD AT THE WATER DEVELOPMENT PROGRAM

The Honorable John S. Doyle
Acting Assistant Secretary of the Army (Civil Works)
Washington, DC

### Looking Back

Your program has me billed to speak about the Water Development Program, and I certainly want to do that. However, I also want to look back a bit. It is just shy of a year since we were presented with the Water Resources Development Act (WRDA) of 1986 (PL 99-662). I think it is appropriate that we take a look at what we have accomplished with it to date.

The WRDA came on the scene with great promise. That legislation of last fall was intended to break loose the political gridlock that had existed between the Congress and the last four administrations. The WRDA was also intended to put the nation's water resources development program back on track.

The heart of the WRDA is, of course, its beneficiary pay reforms---cost sharing and user fees---that make local sponsors active participants in the development process. The US Government's role in water resources development was to evolve from that of "rich uncle" to that of "business partner." Non-Federal partners were now to share greater responsibility, both in planning for water resources development and in financing its costs.

Through these reforms, the WRDA promised to revitalize our languishing water resources development program. It authorized construction of some 300 new water projects, including 50 navigation enhancements and 115 flood control improvements. These new construction projects represent a combined investment value of $16 billion. The act, in effect, constituted a new charter for the CE water resources construction program.

### A New Charter

How effectively have we lived up to that new charter? What is our report card? Well, I think it's pretty good.

The CE and my staff have been working diligently to implement the provisions of the WRDA. The provisions are many---641 to be exact---and the problems are complex. Some will take years to resolve definitively, but working together, we have been making significant progress. We have issued interim or final guidance to the field for approximately 60 percent of the 240 provisions which involve policy.

One major accomplishment was establishment of the Inland Waterways Users Board, which held its first meeting in July and met again on October 27 to develop recommentations to the Secretary of the Army. This board posed tremendous potential to influence the planning process for maintaining and improving our inland waterways system.

We have also been aggressive in implementing the WRDA's 340 project-specific provisions. Of the 51 projects requiring completed Local Cooperative Agreements this year, 43 already have been negotiated and signed, and a number more are in CE headquarters for approval.

## Scaling Back and Phasing

So, we are forging ahead in implementing the letter of the law. What about its spirit? The WRDA issued forth with great expectation. By combining non-Federal money with Federal funds, the WRDA promised to spread limited Federal dollars, supporting a larger volume of construction nationwide. Furthermore, we had predicted that the need to share costs and to finance their share of construction on a pay-as-you-go basis would cause local sponsors to ask themselves, "What can we afford?" as well as "What would we like?" As a consequence, the size of individual projects would be scaled back to more economic dimensions.

We have seen this scaling back come to pass. As an example, the local sponsors of the flood control project at Little Dell Lake, Utah, scaled back the scope of the project, lowering the reservoir by 29 ft and the total cost from $95 million to $49 million. As a result, $22 million in Federal money can now be applied to other water resources development projects.

The effect of downsizing and phasing is even more pronounced in navigation projects. At Baltimore, Norfolk, Mobile, New York, and New Orleans, local sponsors have scaled back the size of the projects. They have also phased construction to mesh with their financial realities and timetables.

At Baltimore, for example, the authorized project provided for a main approach channel 50 ft deep and 800 ft wide. The project now under construction is 50 ft deep but only 700 ft wide. That scaling back of the authorized project, which was based on economic and cost-sharing considerations, represents a deferment of Federal spending of $69 million. As a result of similar scaling back and phasing, the Federal government is spending $95 million less than authorized at Norfolk Harbor, $100 million less at New Orleans, and $113 million less at Mobile. These changes are providing an increased capacity to address the water resources project backlog and, as predicted, are producing a broader distribution of benefits to a larger number of communities throughout the country.

## Budget Credibility

We had also predicted that the beneficiary pay concept embodied in the WRDA would give our program added credibility in the fight for limited Federal funds. Well, the CE Civil Works program has thus far been treated very well in the budget process.

Since agreement was reached in 1985 between the Administration and the Congress over water project cost sharing and user fees that were ultimately enacted in the WRDA, the Adminstration has supported 75 new construction starts for a variety of CE inland waterway, harbor, and flood control projects. These projects will ultimately cost the Federal government $2.7 billion, with estimated savings of $400 million compared to pre-WRDA cost.

Overall, the program has been increased from 1986 to 1987, and the President's FY 88 budget proposed an increase in budget authority of $500 million over comparable FY 86 funding. That represents a 20 percent increase.

So, we are making a lot of progress in implementing the WRDA's provisions, and the law is working out as we had predicted. As a consequence, we have had a slew of ceremonies marking Local Cooperative Agreement signings and ground-breakings over the past few months. Ironically, however, these very successes point out the challenges for the future.

## Room for Improvement

Across the nation---from Fresno, CA, to Quincy, IL; from Little Rock, AR, to New York City; from Rochester, MN, to Mobile, AL---we have started new work on flood control and navigation projects with benefit cost ratios of 2 to 1, 4 to 1, 7 to 1, and even higher. That is good news. The bad news is that these highly beneficial projects have been on our books for up to 30 years!

Example: Redbank-Fancher Creeks, CA. A $65 million investment to protect 38,000 acres in the Fresno-Clovis area valued at $3 billion and supporting 314,000 residents. This investment returned $1.80 in benefits for each $1.00 invested and was first authorized in 1956.

Example: Mobile Harbor, AL. A combined Federal and non-Federal investment of $37 million to improve navigation at that Alabama seaport that will return $2.80 in benefits for each $1.00 invested and was first authorized in 1965.

Example: South Quincy, IL. A flood control project that will protect 3800 acres of valuable cropland and $370 million worth of industrial, commercial, and residential property. A $10 million investment with a 4 to 1 benefit-cost ratio and was first authorized in 1963.

Example: Kill Van Kull, NY/NJ. A $300 million investment to improve navigation channels in and around New York City Harbor that will return $7.00 in benefits for every $1.00 invested and was first authorized in 1955.

Obviously, we have got to do better, and that brings us to the second part of our topic.

## Where Do We Go From Here?

I mentioned earlier that the WRDA gave our program credibility. Our principal challenge now is to maintain credibility. Total Federal resources are very limited. Even with cost sharing, there is no Civil Works program without Federal funding. Our challenge is to continue to get some reasonable share. So, having established the ground rules for individual projects, we now need to win the budget war. To do that we must maintain program credibility.

How do we do that? A primary concern is to make the cost sharing principles work. That means we have to apply the principles equitably and consistently. We have been working on a number of actions to do just that. A draft regulation has been prepared on providing credit for flood control work done by non-Federal interests. That regulation is on track for final publication in the Federal Register by November 1987.

Another provision nearing completion is on ability to pay. This deceptively simple, one-paragraph provision required about six months to work out, but the effort was worthwhile. The proposed rule provides a formula that can be applied evenly and objectively, and it preserves the essence of the WRDA. It was published in the Federal Register in October 1987.

There are a number of things we need to do. First, from a project standpoint, we need to plan projects that are acceptable to the Federal government and the sponsor. We need to move quickly from completion of planning to implementation, and we must complete our projects within established conditions and deliver anticipated benefits.

Second, from a program standpoint, we have to build a substantial number of projects nationwide. Our program must be equitable from region to region, and we need a steady flow of feasibility studies for stability.

We are addressing these project and program concerns in a number of ways. For one thing, I have asked my staff and the senior CE leadership to seriously and creatively address the planning-to-implementation cycle of our program. As a government interested in making economically justified investments for the Nation, it just doesn't make sense for us to unduly put off making these investments.

Addressing these same concerns, a CE Task Force is developing a plan for accelerating planning, engineering, design, and construction for inland waterway navigation improvements. The Task Force seeks to reduce project implementation time from the current average of 21 years to 11-1/2 years.

Another major concern addressed by the Task Force is the need for a systematic, national plan for investment rather than the piecemeal regional approach under which we have been laboring. Of course, this is just a

beginning. It is going to take a lot of time and effort to reach these objectives, but I am encouraged by the start we have made.

Another course we are pursuing toward a well-planned, well-managed national program is returning the CE to a biannual funding bill. The program is easier to manage in smaller bites and avoids the costs associated with a larger funding bill. Therefore, we have submitted for FY 89 a modest, 14-provision bill. We also anticipate that future budget proposals will also provide for a steady flow of feasibility studies that will keep our program stable.

Let me mention one other area where we need to guard our credibility, that is, the execution of our regulation responsibilities. Since the beginning of this administration, we have been aggressively pursuing regulatory reform. We have made considerable progress in this area, eliminating duplication and reducing the multilayer appeal system. We have been successful in simplifying the permitting process.

However, we want to reduce the permitting time still further. To do that, we need greater efficiency. We can obtain that only by devoting additional resources---we need more people. We want to do things faster, but we also must do them right. While potentially a two-edged sword, I think this is an approach that will maintain our program credibility in business and environmental circles alike.

## Conclusions

In conclusion, the WRDA has given the Army Civil Works program new life and the CE a new charter. While there is always room for improvement, I am gratified by the enthusiastic response to this new beginning, both within and outside the CE.

Our Nation's water resources development program is back on track. To keep us on track, I solicit your support in meeting our most serious challenge. We must avoid the dual temptations to make exceptions to the new cost-sharing principles and to add excessive numbers of new projects to the President's budget. From the House and the Senate markups of the President's budget, it seems that it may take some time before all the parties are convinced that exceptions to the WRDA reforms are not in the interest of the Nation or the Army Civil Works program.

In the meantime, for the future of our nation's water resources development, I seek your support in resisting efforts to return to the old ways of funding Civil Works projects. We had just as soon pass on the pork! Thank you very much.

## FEDERAL AGENCY VIEWPOINTS PANEL

# THE US ARMY CORPS OF ENGINEERS NATIONAL DREDGING PROGRAM "ACCENTUATING THE POSITIVE"

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## The National Dredging Program

Ladies and gentlemen, I am here today to talk about dredging, which is one of the major missions of the CE and a program which offers many opportunities for beneficial uses and cost reductions. The national dredging program is large. In the maintenance of 25,000 linear miles of inland and coastal navigation channels the CE has constructed over the year, we excavate about 285 MCY of sediment each year at a cost of over $400 million.

The dredging program is also very important to regional and national economies. Navigation channels dredged by the CE serve 400 ports which handle almost 2 billion tons of commerce each year, and foreign trade handled through these ports accounts for one out of every five jobs in the United States. The inland waterway system serves 130 of the nation's 150 largest cities and is a conduit for one-sixth of the nation's intercity freight. The waterway system is vital to the flow of domestic and foreign commerce because it offers the least expensive and most energy-efficient transport mode for such bulk cargoes as coal, grain, petroleum products, chemicals, iron, and steel. In addition, the waterway system has proven to be of great importance to our defense efforts in the past and is an essential element to our current mobilization readiness posture.

The enactment of the long-awaited and badly needed WRDA has had, and will continue to have, a dramatic and positive impact on the National Dredging Program. The new legislation authorizes 50 new navigation projects, 24 shore protection projects, and 12 navigation project extensions, most of which will involve dredging.

I estimate that $200 million will be expended for the improvement projects over each of the next 5 years. Combining this with the annual maintenance dredging program results in a total annual program of $600 million or a 50 percent increase over the recent average. I also estimate that the expenditure for improvement projects over the next 10-year period will be about $2 billion. I believe that the inland waterway dredging program will amount to one-third of the total national dredging program, a sizable amount by anyone's standards.

After enactment of the legislation, which occurred on November 17, 1986, it was necessary that local cooperation agreements be finalized and signed by the CE and the local sponsors. This took some doing, but even so, we have placed about $172 million in dredging work and are well on the road to the

$200 million target we established for this fiscal year. This level of progress clearly demonstrates that cost sharing works.

Our extensive research program, which has been carried out since the early 1970's, indicates that 90 to 95 percent of the material we dredge each year is uncontaminated. Therefore, all of us should concentrate on how this large quantity of dredged material can be used beneficially. I chose the topic, "Accentuating the Positive," because I am convinced there are significant benefits being realized now, and that the scope of these benefits will increase as we place dredged material associated with the navigation improvements authorized in the WRDA.

I do not want to convey a lack of concern for the 5 to 10 percent of the dredged material that is contaminated. The CE is very concerned about this problem, and we devote a great deal of thought and effort to it. However, it seems reasonable to me that since 90 to 95 percent of the material we handle is not contaminated that we should devote at least 50 percent of our time and effort to beneficial aspects.

Along these lines, let us think for a few minutes about terminology and its psychological impacts. "Borrow area" and "spoil area" are terms that have been used in the general construction field for many years in reference to cut and fill operations. In dredging, we have used these same terms to describe areas where we excavate and where we place dredged material. The word "spoil" conveys an unpleasant and undesirable thought. The words "disposal" and "borrow" do not have positive impacts either. If we in the engineering, scientific, and business professions choose to use words and terms with negative impacts, how can we expect the public not to think in negative terms? So, let us clean up our language when we talk about uncontaminated dredged material. Instead of "spoil areas" and "disposal areas", why not use "placement areas" or "relocation areas"? Again, it is a matter of accentuating the positive.

## The CE Beneficial Uses Initiative

The CE has been identifying and applying beneficial use of dredged material techniques for a long time. We have been very fortunate to have an active research program, which has been supportive of our objectives. Under this program, we have identified the nature of the material we dredge---the 90 to 95 percent referred to previously. As we developed and confirmed this information, we directed our efforts toward how the uncontaminated material could be used in environmentally and economically acceptable ways while at the same time accruing national resource benefits to society. A great deal of information has been developed on beneficial uses over an extended period, but until recently, we did not do a very good job of compiling the results of our national program and making the information available to Federal and State resource agencies and the public.

The steps we have taken to correct this situation are as follows. First, we have compiled our experiences and findings along with information available from other Federal and State agencies into an engineer manual entitled "Beneficial Uses of Dredged Material." This document, which was prepared by

Dr. Mary Landin of WES in Vicksburg, MS, is an excellent summary of the beneficial uses of dredged material on a wide variety of project applications. Twelve different beneficial use application thrusts are presented in the manual. They range from wetland habitat development and aquaculture to strip mine reclamation. The manual has proven to be a "best seller," with nearly 3,000 copies in distribution from the second printing. Copies are available from WES and from the US Government Printing Office.

Second, we hosted an interagency workshop on beneficial uses of dredged material in Pensacola, FL, in October 1986. Co-hosting agencies which participated in the workshop were the National Marine Fisheries Service (NMFS), the US Fish and Wildlife Service (FWS), and the US Environmental Protection Agency (EPA). Also in attendance were representatives of several state resource agencies, consulting firms, and environmental groups. This was the first national workshop on the subject, and it proved to be quite successful. The proceedings of this workshop have been compiled, and copies can be obtained from WES.

Third, our North Atlantic CE Division sponsored a regional workshop on beneficial uses of dredged material in Baltimore, MD, in May 1987, which was hosted by the Baltimore CE District. Proceedings of this workshop are available from WES and from Baltimore District.

Fourth, in coordination with Federal and State agencies, we arranged this interagency workshop on beneficial uses. As many of you know, the Pensacola workshop activities were largely related to coastal ports and the nearshore zone. The theme and topics of this first-of-its-kind workshop are focused on inland waterway activities and projects. We are delighted that Dr. Laurence R. Jahn, President of the Wildlife Management Institute, Washington, DC, has agreed to be our moderator. On the Army side, we have our heavy hitters---Mr. John S. Doyle, Jr., Acting Assistant Secretary of the Army for Civil Works, and BG Peter J. Offringa, Deputy Director of Civil Works. As was the case in Pensacola, many of the technical presentations will be made by people not associated with the CE. Aside from the technical presentations, time is being set aside for discussion groups so that attendees can express their views and comments informally.

## Accentuating the Positive

Now, I'd like to return to "Accentuating the Positive." With the new WRDA and the 50 percent increase in the scope of the national dredging program, now is the appropriate time for us to consider some new and innovative concepts for dredged material beneficial uses. It is also important that we consider extending or expanding those areas in which beneficial uses have been demonstrated successfully.

### Weaver Bottoms Restoration

One of the most interesting papers given at the Pensacola workshop was on inland waterways by Richard Berry and Dennis Anderson on the Weaver Bottoms Wetlands Restoration Project in the Upper Mississippi River. It was presented

by Mr. Berry and illustrated the environmental benefits and cost savings which can be realized when agencies, in this case the CE and FWS, cooperate to accomplish a common goal.

Those of you who attended the field trip yesterday know that Weaver Bottoms is a backwater area in Pool 5 about 100 miles downstream of St. Paul, MN, and it covers about 4,000 acres. The pool was created by the construction of the CE lock and dam to establish the 9-ft navigation channel. Initially, the project provided a wide diversity of rich habitats for both plant and animal species. By the 1980's, however, the overall productivity has decreased due to erosion.

The CE and the FWS developed a restoration plan where the CE would use material from existing dredged material islands to build plugs between the worst side chutes that were causing the erosion, to construct barrier islands, and to form a riprapped downriver structure that would partially close off the downriver entrance to the Bottoms. This cooperative effort was widely acclaimed by State and Federal agencies, and for the CE, it resulted in cost savings to the dredging program by allowing them to reclaim filled disposal areas needed for maintenance dredging.

As I listened to Mr. Berry, I became convinced that we needed to further explore the potential for beneficial use of dredged material in inland waterways. That is why we made the arrangements to hold this workshop in St. Paul.

## Successfully Tested Beneficial Uses

The beneficial uses engineer manual lists a number of beneficial uses, including: wetland, upland, island, and aquatic habitats; beaches and beach nourishment; aquaculture; parks and recreation; agriculture, forestry, and horticulture; strip mine reclamation; land use concepts; industrial, commercial, and urban uses; and shoreline stabilization and erosion control. We have an ongoing demonstration project on aquaculture in Galveston CE District where shrimp are being produced inside a confined disposal facility (CDF). This CDF is being used for aquaculture between maintenance dredging cycles in the Brownsville, TX, area.

Wetland creation using dredged material is a well developed beneficial use that has been refined to the point where we can develop wetlands even in areas which are subject to moderately erosive wave energies. To date, we have developed or restored thousands of wetlands in coastal and interior waterways, and thousands of additional acres are in the planning stage. While there are many examples of beneficial uses of dredged material in various locations around the country, there are not as many examples as I would like to see relative to the inland waterway system. I hope that during the course of this workshop, we will find many instances of wetland creation or, as a minimum, opportunities for additional wetland creation in the future.

One of the most spectacular of the beneficial uses of dredged material is waterbird nesting on islands we have created in waterways throughout North America as a result of dredging. Hundreds of thousands of 37 species of colonial waterbirds nest on these dredged material islands each year. These include herons, egrets, ibises, terns, skimmers, pelicans, spoonbills,

cormorants, and gulls. Some of these species are rare, and let me emphasize that they would be even more rare if these islands were not there. We are very proud of the fact that some of these dredged material islands are now under the management of the National Audubon Society and other conservation groups.

The use of dredged material placement sites for recreational purposes is often closely associated, on the one hand, with habitat development for fish and wildlife, and on the other hand, with the development of pocket beaches, picnic and camping areas, bird watching, hiking, and boating. For example, recreational fishing and waterfowl hunting are very important elements of Pointe Mouillee, a 4,600-acre wetland restoration project in western Lake Erie. This is a joint effort of the Detroit CE District and the Michigan Department of Natural Resources.

One type of beneficial use that is often overlooked which is applicable to inland waterways is the development of upland placement areas for an improved wildlife habitat. Under this approach, the beneficiaries include white-tailed deer, small mammals, nesting geese and other waterfowl, and numerous species of songbirds.

Aquatic Habitats

There are many opportunities for the productive use of dredged material in the aquatic habitat development area. They include sport and commercial fisheries enhancement, gravel riffle beds for endangered or threatened species, construction of clam and mussel beds, oyster flats, fishing reefs, freshwater and saltwater aquatic vegetation, and underwater berms to intercept and trip large storm waves. By doing so, these berms reduce shoreline erosion rates.

It would be natural, I suppose, that some of you might be thinking---are there really true benefits or not? Let me give you two specific examples. Dr. Andrew Miller of WES recently contributed articles to the CE's Engineer Update newsletter and the Engineering News Record. The articles describe how a WES design was implemented to create a habitat conducive to the growth of freshwater mussels and clams and for use by fish and other organisms that require a gravel substrate and flowing water.

In the vicinity of Mound City, IL, a tug moved barges to a site about 200 ft from the Kentucky shoreline where gravel was then placed in the Ohio River. The gravel was obtained from nearby deepwater sites where there was little aquatic activity. WES will conduct biological and physical studies at the site over the next several years to determine the level of success achieved. This is the second location where a gravel bar designed by WES has been constructed. The first such bar is located in a section of the Tombigbee River near Columbus, MS.

Dr. Miller indicated in the article that "freshwater mussels are a resource with economic, cultural, and ecological value. Their meat is edible, and the shells can be used to make ornaments and pearl buttons." I cannot testify to their ornamental worth, but if they are anything like "mussels in Brussels," then I am a strong advocate for the program! The Consolidated

Grain and Barge Company paid for the construction of the gravel bed, and the Tennessee Valley Authority assisted during the construction phase.

Chesapeake Bay Marine Habitats

While we inherently know that many of these benefits occur, it is essential that we document the circumstances and results obtained in demonstration projects. This requires determining the baseline conditions prior to the dredging operations, then monitoring the conditions after the dredging and placement activities are completed. We have two such demonstration projects underway in Chesapeake Bay.

In one case, we have placed dredged material inside a designated oyster bed that has been dormant and unproductive for a long time. We felt that the silt layer was so thick in the designated oyster bed that the seeded shells sank to a level where the spats could not reach them. Our approach was to construct a mound using dredged material that protrudes above the silt layer so that the spats can attach themselves to the shells. We designed a diffuser, which acts somewhat like a hydroclone, to minimize dispersion of the material during construction of the mound. The Maryland Department of Natural Resources was very helpful in working with the Baltimore CE District in developing this plan of action.

Furthermore, the State staff is offsetting the CE expenditure by seeding the mound or berm with shells and also by conducting shell and spat surveys. I understand that we should get an indication of whether the demonstration will be successful within the next several months.

Over an extended period, the marine harvest in Chesapeake Bay has declined over 80 percent. Therefore, this is a very important demonstration project. There are hundreds of acres of dormant oyster beds in the Chesapeake Bay area, so if our efforts are successful, there will be an opportunity for widespread application of the plan, as well as the potential for long-term use.

The Baltimore CE District is also working closely with the Maryland Department of Natural Resources in an effort to create an environment suitable for the growth of the seagrass *Zostera marina*. This seagrass is conducive to the growth of crabs and other shellfish with commercial and recreational value.

We feel that there are two factors which have contributed to the loss of eelgrass in the Bay. First, the wave energy may be too strong to allow immature plants to get established. Second, the water depths are probably too great to sustain the growth of this seagrass. Therefore, we took two actions to accomplish this demonstration project. We placed a longard reinforced plastic tube filled with sand in an offshore area to intercept and dissipate storm wave energy. Between the submerged longard tube and the shoreline, we placed dredged material to create a more gentle underwater slope and planted *Zostera* in the slope area in August 1987.

A recent check showed that the seagrass has remained in place and is still very green. By next spring, we should know whether our approach to this

problem is successful. If this should prove to be the case, this will be another example showing how the concept can be used on a wider basis and for an extended period of time. In both of the above cases, the CE and the State of Maryland are monitoring the projects so that success or failure can be properly documented.

Parks and Other Beneficial Uses

Dredged material placement sites can be used to build parks. Belle Isle Park in Detroit and Hains Point Park in Washington, DC, are excellent examples of large, heavily utilized city parks. Mud Island, a highly developed park in Memphis, TN, was constructed on dredged material. It is a very attractive development and includes restaurants, a river museum, a model of the entire Mississippi River, and an amphitheater that seats several thousand people.

Other examples of beneficial uses resulting from dredged material disposal sites include aquaculture ponds, salmon hatcheries, port developments, riverside and shoreline facilities, and airports such as Washington National, Portland, San Francisco, LaGuardia, and Kennedy International. Shoreside developments include shopping centers such as Pony Village in Coos Bay, OR, and Port Center in Vancouver, WA. Other examples are marina and boat harbor improvements, residential and urban areas, solid waste landfills, abandoned mine and gully fills, and strip mine reclamation.

Placement areas that have been filled to capacity are used for agricultural purposes in many locations around the country. In addition, we have placed dredged material in thin layers over large areas adjacent to waterways which are used for cattle and other livestock grazing. Filled disposal sites are also utilized for growing pulpwood, rice, soybeans, corn, and millet.

Another beneficial use of dredged material is bank stabilization. In a number of lakes and rivers, dredged material coupled with riprap placement is being used for this purpose. I would think there would be a large number of locations along the inland waterway system where we could apply this technique. There are numerous success stories that will be discussed over the next two days, and these will be included in the published proceedings.

For the CE point of view, I assure you that we will continue to make the dredging operations more efficient and less costly while working toward enviromentally acceptable alternatives. The WES Environmental Laboratory will continue to provide the latest in research and technology on the beneficial uses of dredged material, and CE Districts and Divisions will continue to work diligently with the resource agencies and environmentally oriented groups to make the best possible use of dredged material.

In most cases, it is not a question of whether to dredge or not; we must do so because of the significant economic, energy, and defense importance of our navigation system. Our job, as I see it, is to study and evaluate all of the reasonable alternatives and then to move ahead with the most effective, environmentally suitable, and cost efficient options so that we can keep our waterway system viable. It is to the nation's benefit that we all work together to achieve this objective.

## Underwater Berms

During the national workshop in Pensacola in 1986, I referred to two underwater berm demonstration projects that were under consideration for application in the coastal zone. During February, we placed about 430,000 cu yd of material along the 18- to 19-ft depth contours downdrift of the entrance channel serving the Port of Mobile, AL. Immediately after placement of the feeder berm material, we began a monitoring program to determine whether the dredged material would remain within the nearshore coastal regime; i.e., between the surf zone and the 35-ft depth contour. The monitoring program, which includes wave riders, sediment sampling, seabed drifters, and current direction and velocity meters, will continue for another year.

We expect the feeder beach material to move downdrift, but we also expect a large percentage of the material to remain in the nearshore regime. If this should be the case, the material will contribute to a more gentle underwater slope, which in turn would reduce or retard the shoreline erosion rates. Because of close and continuing collaboration with environmental groups, there have not been any objections to this interesting project.

In addition, we plan to place about 11 MCY of dredged material from the deepening of the Mobile Project along the 40- to 42-ft depth contours downdrift of the Mobile Entrance Channel to create a stable berm. This work, which is scheduled to begin next month, will result in a large mound with very gentle side slopes. We expect the majority of the stable mound material to remain in place and to intercept or trip large incoming storm waves which will reduce the wave energy reaching the surf zone. This in turn will reduce the shoreline erosion rates.

I have mentioned these two projects because they have progressed from the planning to the implementation stage. I feel that by working closely with environmental and conservation groups we can bring to fruition many of the different types of beneficial uses which I have mentioned today. The key to making this happen was summarized very well by Mr. Warren T. Olds, Jr., FWS, in his closing remarks at the Pensacola workshop. He stated that the reasons for the successful implementation of the beneficial use concepts are "effective and harmonious planning, an early involvement with the primary parties involved, an effective open communication, and very close cooperation and coordination."

## Conclusions

This will be the last national workshop on the beneficial uses of dredged material in which I will participate as a representative of the CE because I intend to retire early in January 1988. I will leave the CE with no regrets; on the contrary, I have enjoyed a very rewarding career. I will be leaving with the feeling that our relationships with the other Federal and State agencies have never been better and that you folks and others interested in navigation activities will expand the types of beneficial uses that I have discussed today.

In addition, I leave with the knowledge that the cost-sharing concept is a viable option which will result in many navigation improvements finally getting underway. We are already off to a flying start with several navigation improvement projects in progress, and this is only the beginning. There are many more to come.

## FEDERAL AGENCY VIEWPOINTS PANEL

## THE US FISH AND WILDLIFE SERVICE PERSPECTIVE

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If there is a theme to my remarks, it is, "Cooperation is the key." The FWS fully supports beneficial uses of dredged material. Beneficial use is our number one priority for disposal of dredged material because it accomplishes our primary goal of avoiding or minimizing impacts to fish and wildlife resources. Often there are social benefits to nearby communities as well. Across the country, we commit staff time to accomplish these uses. We realize that beneficial uses of dredged material cannot be accomplished without extensive cooperation and coordination between Federal agencies such as the FWS, the NMFS, the EPA, the CE, State and local governments, and private interests.

There is little doubt that achieving the goal of beneficial uses requires much more effort on the part of the participating agencies than any other method of disposal. Ideas must be formulated years in advance. Local sponsors must be contacted, and any easements must be acquired. State permits must be obtained, and finally, the site must be prepared. Again, cooperation is the key to the whole process.

In cooperation with other agencies, the FWS has found productive and creative beneficial uses of dredged material. What I will do now is briefly discuss some of these "success stories" and give a few comments on how the process might be improved even further. For this presentation, disposal will fall into the following categories: (1) road maintenance and ice control, (2) fill for construction and development, (3) fill for levee construction or repair, (4) environmental or recreational enhancement, and (5) endangered species habitat creation. I will first discuss examples from the Upper Mississippi River; then the Great Lakes; the Ohio River; and the Sacramento/San Joaquin River delta, CA.

### Upper Mississippi River

Material dredged for navigation channel maintenance on the Upper Mississippi River is primarily sand. Road maintenance and ice control require that stockpiles of sand be located in an area accessible to both road equipment and dredging operations. Material provided at readily accessible sites, either urban or rural, is in high demand. In more remote areas, finding appropriate stockpile sites is challenging. In addition, local contacts must continually be advised of the availability of the dredged material. A recent survey by the Rock Island CE District of potential users of sand at stockpile sites in Missouri concluded that the demand on an annual basis would be greater than the projected supply of material from channel maintenance operations. Because

of these promising conclusions, the Rock Island District has initiated engineering and design for improvement of the access road to the stockpile site. This access road will enable greater quantities of material to be trucked away, allowing continued use of the existing site for channel maintenance disposal while avoiding additional impacts to fish and wildlife resources from stockpile expansion.

Use of sandy dredged material for construction fill has been very successful on the Upper Mississippi River. When shoals are mechanically dredged, the material may be placed directly into a private barge and hauled away for industrial uses. The dredge THOMPSON removes almost 1 MCY of sand from the navigation channel each year. If you have seen the THOMPSON, you will know that it is anything but delicate! In fact, she pumps a large volume of water along with her sand load; therefore, it is a little tricky just to stockpile it. As a result, material to be used for construction fill generally must be stockpiled at an open, easily accessible area and rehandled by truck or barge to construction sites. In the St. Paul CE District, 300,000 cu yd of dredged material were barged from a stockpile site to Winona, MN, to provide fill for a discount store site. The transportation costs for the material were shared between the developer and the CE. Benefits to the developer accrued in terms of cheap fill, and benefits to the District were predicated upon prolonged reuse of an existing disposal site.

Use of sand dredged from the main or navigation channel for levee repair or construction is a common engineering practice. When the THOMPSON is used in connection with shoal removal to maintain navigation, placement of the material along a levee is difficult. Water runoff from the material into adjacent drainage districts can cause problems with farmers. Water from the pipe can also cause levee failure. There are many examples on the Upper Mississippi River where the obstacles have been overcome through extensive coordination, and the needed levee improvements have been achieved. This year, an additional levee section of the Green Island Wildlife Unit in Iowa will be raised about 3 ft. This will complement a similar raise made several years ago with dredged material.

Sand from the Mississippi River channel has also been used for creation of recreation sites, specifically, beaches. Beaches can be a mixed blessing. If placed in valuable fish and wildlife habitat, beaches can obviously be destructive. If placed in "approved" sites, such as those identified under the GREAT process, beaches can be an important component of recreational use of the river. There have been numerous beaches created with sand at approved Mississippi River sites.

The use of dredged material for environmental enhancement is one near and dear to the hearts of resource biologists. We are constantly asking ourselves, "Is there something we can do to actually improve the existing resource value?" While the jury is still out on some efforts, in others we can say a definite "yes." Many of you saw yesterday the Weaver Bottoms restoration in Pool 5 of the Mississippi. This project is intended to rehabilitate a 4,000-acre backwater for waterfowl in part by utilizing dredged material from the navigation channel to reduce further sedimentation and reduce wind fetch. Weaver Bottoms is a joint effort of the St. Paul CE

District and the FWS. I believe you will hear more about this project from presentations later in the conference.

In the Rock Island CE District near Keithsburg, IL, a 5-acre clearcut area in a bottomland hardwood forest adjacent to the Mississippi River was recommended as a dredged material revegetation project. First, the topsoil was scraped off and stockpiled. Then the area was pumped full with sand during several dredging cycles. When capacity was reached, the topsoil was bulldozed back over the sand, and the area was planted with native prairie grasses. In a similar nearby project, organic silts from an adjacent backwater will be dredged and pumped over the sandy dredged material. These revegetation projects provide habitat diversity in monotypic silver maple and eastern cottonwood stands commonly found in Upper Mississippi River bottomlands.

## The Great Lakes

Via coordination between the Detroit CE District and the FWS's East Lansing Field Office, efforts are currently underway to utilize dredged material from the Great Lakes navigation channel to create sand islands for use by nesting piping plovers. If this effort comes to fruition, it may assist in the recovery of this Federally listed endangered species.

## The Ohio River

As a result of coordination between the Louisville CE District and the FWS's Marion sub-office, a mussel bed was developed offsite as compensation for mussel habitat losses caused by dredging for a barge fleeting area. This effort was successfully carried out via the Section 10/404 permit process. I believe a presentation will be made on this project later in the conference.

## Sacramento/San Joaquin River Delta

Dredged material from the Stockton Deepwater Channel was used to create dredged material islands in the delta, as compensation for wetland losses. These islands are intended to provide resting, feeding, and nesting for waterfowl, shorebirds, and riparian bird species. Studies are ongoing to determine the value of these islands as bird habitat. This project was the result of a cooperative interagency effort, primarily between the FWS's Sacramento Field Office and the Sacramento CE District.

## What Can We Do To Make It Better?

I have given you several examples of inland waterways beneficial uses with which the FWS is involved. I would like to stand back now and discuss

ways in which beneficial uses of dredged material might be enhanced or improved. Beneficial uses often hinge on an affirmative determination by private or public dredging concerns that any additional costs associated with modified disposal methods are justified. We hope that those who develop the justifications will take into account environmental and social benefits over the long-term. Don't just look at short-term "start-up" costs and benefits.

With regard to Federal dredging projects, the WRDA provides some new policies for implementation by the CE. We applaud the WRDA thrust toward cost sharing by project beneficiaries, but we also hasten to point out that the WRDA clarifies Federal responsibilities in several areas. First, costs for enhancement of habitats for endangered species and other species of national importance, such as migratory birds, are to be 100 percent Federal. We strongly support the use of dredged material to enhance endangered species and migratory bird habitats. Also, the WRDA provides authority for the CE to develop new environmental features at its completed projects.

We also support the development of a beneficial uses network. This network could be used to coordinate with all potential uses within a given project range. On the Mississippi River, we believe such a network approach could greatly improve our ability to accomplish beneficial uses.

## Highlights of Upper Mississippi River Dredging

As I wrap up, I would like to highlight dredged material disposal procedures on the Mississippi River, in all honesty, partly because it is a process with which I am familiar but also because it is a process that has proven to be very effective for dealing with dredged material disposal.

In 1973, the CE prepared the Environmental Impact Statement for the 9-ft navigation channel for the Upper Mississippi River. The study revealed that methods of channel maintenance, especially dredging and disposition of dredged material, were damaging the fragile backwater areas, marshes, and sloughs for which the river is famous. As a result of Congressional and public interest, the North Central CE Division Engineer and the FWS Regional Director announced in September 1974 that they planned to establish a partnership team. The team would work out a long-range management strategy for the multi-purpose use of the river. This agreement led to the development of GREAT, set up in October 1974 as a working partnership of Federal agencies and the river-bordering States of Minnesota, Iowa, Illinois, and Missouri. The Great River Environmental Action Team (GREAT) studies were divided into three reaches: GREAT I from Minneapolis to Guttenberg, IA; GREAT II from Guttenberg to Saverton, MO; and GREAT III from Saverton to Cairo, IL. These correspond to the three CE Districts of the Upper Mississippi River.

One of the most important products of the GREAT effort was the development of formal interagency coordination procedures for channel maintenance dredging in each of the three CE Districts: St. Paul, Rock Island, and St. Louis. This process for disposal of dredged material has worked well for over 10 years. The reason it has worked so well is that the agencies involved, the CE, the FWS, and the States of Wisconsin, Minnesota, Iowa,

Illinois, and Missouri, want the process to work. That is, the people involved with the process want it to work. Again, cooperation is the key.

How successfully a beneficial use application works depends upon a variety of factors. We will discuss many of these during this conference. Examples are the type of material, logistics, economics, permits, etc. The key factor, however, is the willingness of the participants, as agencies and as individuals, to come to an agreeable solution via a give-and-take process. The FWS has been productively involved in cooperative efforts to beneficially utilize dredged material for a number of years and in a variety of applications. We are here to stay.

## FEDERAL AGENCY VIEWPOINTS PANEL

### US ENVIRONMENTAL PROTECTION AGENCY VIEWPOINTS ON BENEFICIAL USES OF DREDGED MATERIAL

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Chicago, Illinois

The USEPA is not as actively involved in the research and development programs for beneficially reusing dredged material as are the other agencies represented at this workshop. EPA has more of a regulatory role in dredging and disposal operations under Section 404 of the Clean Water Act. However, we in Region V have funded a small number of beneficial reuse research and demonstration projects over the past few years.

Region V encompasses six states in the Great Lakes region. The bulk of the dredged sediments we regulate under Section 404 are from Great Lakes harbors and tributaries. In 1985 and 1986, an annual average of 4.5 MCY of sediment was dredged from the US Great Lakes by the CE for the maintenance of harbors and waterways for commercial navigation. In 1985, approximately 60 percent of this material was classified as contaminated and required some type of confinement with the large majority being placed in confined disposal facilities. This is in contrast to the approximately 90-95 percent of dredged sediments classified as clean from the Nation as a whole.

The quantity of material beneficially used from the Great Lakes, although relatively small, has been increasing. In 1979, only 1 percent of all sediment dredged by the CE from the Great Lakes was beneficially used for beach nourishment. By 1986, this amount had increased to 10 percent or about 500,000 cu yd. Thus, a great potential still exists for beneficially reusing dredged material from the Great Lakes.

I would like to briefly review a number of the beneficial reuse projects we have supported in Region V. We have gotten involved in two inland lake projects. The first was at Lake Paradise, located in central Illinois. In 1981, some experimental work was conducted using dredged sediments in land spreading applications. This work was funded in part by a grant from EPA to the Illinois Department of Agriculture under Section 208 of the Clean Water Act. The effect of 18 in. of dredged sediments on corn yield was examined. It was predicted from experimental plots that the 18 in. of sediment would produce $100/acre returns increase, compared to local untreated soils, due to increased yields and lower fertilizer requirements. A larger scale experiment using hydraulically pumped sediments was planned; however, the funding was not available to do this.

Some developmental work is currently being conducted at Lake Springfield, IL. The city of Springfield is looking at the potential use of dredged sediments in land spreading applications. They have conducted some work in growing sudan grass on various combinations of sediment and soil in a

greenhouse. Results have shown that of all treatments, the 100-percent dredged sediment treatment produced the greatest yields of sudan grass. The State of Illinois has subsequently been awarded funds under the Clean Lakes Program for restoration of Lake Springfield. Although the beneficial reuse work was not specifically funded in FY 87, Clean Lakes Program funds can be used for such work.

In the Great Lakes arena, we have provided funding under Section 205(j) of the Clean Water Act for developing beneficial uses for clean sediment dredged from Toledo Harbor in Lake Erie. The Toledo Metropolitan Area Council of Governments is examining the feasibility of mixing the sediment removed from a confined disposal facility (CDF) with sewage sludge to produce a top-soil quality soil. Some experimental work has been conducted with grasses.

So, EPA funds are available for planning, experimentation, and implementation of beneficial reuse projects, particularly through Section 205(j) and the Clean Lakes Program.

Aside from these localized efforts, there is one very interesting and complex issue regarding beneficial uses we have been working on in the Great Lakes Basin, the issue of CDF's. The CE has constructed about 30 in-lake CDF's for the disposal of contaminated dredged sediments.

These in-lake CDF's provide a great nesting habitat for a variety of waterbirds as well as a prime aquatic habitat. The riprap dike walls provide an excellent feeding and breeding ground for fish. The question we are addressing is whether this aquatic habitat creation is truly beneficial, or are the aquatic organisms inhabiting and/or using this habitat accumulating toxicants that are being discharged through the CDF into the lake. This is one issue with which the CDF Interagency Working Group is currently involved. This working group is composed of representatives from the EPA, the CE, and the FWS.

To help answer this question, we conducted a pilot biomonitoring study at the Saginaw Bay CDF this past summer. We looked at PCB congener specific uptake in caged minnows, clams, crayfish, and hexane dialysis bags as well as in the local *Cladophora* community. The project goal is to determine whether organisms caged outside the CDF have a PCB congener component similar to organisms caged inside the CDF or to organisms caged at a reference (control) site. This should provide information as to whether or not the biota inhabiting the dike wall are bioaccumulating contaminants as a result of leakage through the wall. The results of the pilot study, as well as that from a larger scale study to be conducted in 1988, should provide enough information to help solve this problem.

To conclude, it is apparent that only a small portion of the dredged sediments in Region V are being beneficially reused. The challenge is there for the Federal, State, and local agencies to actively pursue the development of this disposal alternative for clean as well as contaminated material. The EPA, although not directly involved in beneficial reuse research, has funded mechanisms available for developing reuse alternatives. We realize that solutions are not easy; however, we would hope that as a result of this workshop, an impetus can be provided so that if we meet again in a few years, we can

demonstrate an increase in the amount of dredged sediment being beneficially reused in the Great Lakes and inland waters.

## FEDERAL AGENCY VIEWPOINTS PANEL

# DREDGED MATERIAL STABILIZATION FROM A SOIL CONSERVATION SERVICE VIEW

Robert J. Glennon
National Plant Materials Center
USDA Soil Conservation Service
Beltsville, Maryland

The USDA Soil Conservation Service (SCS) has worked on critically eroding areas throughout its 50-year history. From gully stabilization in the 1930's to nuclear waste disposal site reclamations in the 1980's, SCS has been assisting landowners and land managers on grading and revegetating critical areas. Dredged material poses the same conditions we have worked with in sand and gravel pits, mines, and eroding streambanks. An unconsolidated soil mass with a certain texture, drainage, pH, fertility, and untended land use poses a significant challenge for reclamation. Many plant species have been cultivated, and cultivars have been developed specifically for critical areas. For example, some of these are: "Streamco" and "Bankers" willow for streambanks; "Tioga" deertongue; "Lathco" flatpea; "Arnot" bristly locust for coal mines; and "Chemung" and "Emerald" crownvetch for roadsites.

Most plants used on critical areas have been developed and cultivated for other land uses. Those typically used for low intensity activities such as forage or wildlife habitat can also be used on critical areas for the same purpose. The plants developed for these uses have been established and utilized with a minimum of fertilizer and no irrigation or pesticides. The plants developed for intensive activity such as parks or athletic fields need better site preparation and a much higher level of maintenance.

To properly stabilize an area, plant materials must first be matched with the intended use of the area and the physical characteristics of the dredged material. Soil texture, permeability, pH, fertility, and any toxic materials must be considered. The intended level of maintenance must also be considered. Establishing a turfgrass with a high fertilizer and mowing requirement, for example, is not a good investment if an adequate maintenance budget is not available.

The choice of plant materials will vary with soils as well as with geography. In the northeast, for example, warm season grasses such as switchgrass, big bluestem, and lovegrass can be used on dredged material with less than 15 percent fine soil particles. Cool season legumes such as flatpea, perennial pea, and crownvetch can be used with more than 15 percent fines, and cool season grasses such as tall fescue, timothy, and orchardgrass can be used only with more than 20 percent fines. In the northwest, sweetclover, hairy vetch, and beachpea are legumes used on sandy soils while birdsfoot trefoil and white clover are best for fine-textured material.

Scheduling an area for revegetation is a critical step in reclamation. Most plants have a rather narrow window when they can be seeded or

transplanted. Optimum dates vary widely from one area of the country to another and from species to species. It is very important to stay within specified dates to insure optimum germination, survival, and growth. The dates have been devised to provide optimum conditions for germination or planting and to avoid harmful periods of drought, heat, and frost. Species which can be planted to provide temporary cover until the next optimum seeding date are commercially available and will protect the area. The cost of a temporary seeding will always be less than that of a permanent seeding which fails.

Site preparation and the mechanics of seeding or planting are also important. Although a completely smooth planting area is not necessary, the smoother the area, the less the concentrated flow, the easier to mechanically seed and pack an area, and the better to plant wetland species by elevation. Hydroseeding and broadcasting seeds by helicopter and tractor is expensive and usually is not as effective as drilling or spreading the seeds with a precision seeder. Any seeding should be compacted to be minimally effective, and pulling a packer connected to a drill or seeder costs little more than pulling a packer alone.

Drilling the seeds also provides control of seeding depth. The ideal depth of a seeding may vary from a 1/4-in. depth for a warm season grass such as switchgrass with 390,000 seeds/lb, to 1-1/2 in. depth for a cool season legume such as flatpea with 10,000 seeds/lb. Variation of even a half inch may reduce germination by as much as 50 percent. Vegetative propagules have the same kinds of tolerance as seedings. Rhizomes and corms only have an inch tolerance on a 3- to-4 in. planting depth. Bare root plants only have a 2- to 3-in. tolerance on a 8- to 12-in. depth.

Protection of the permanent seedings or plantings with mulch and an annual nurse crop is essential to control erosion on upland sites. A wide variety of mulch materials is available, from self-tacking wood fiber to excelsior attached to plastic netting, to straw that must be anchored with asphalt, netting, or a mulch-anchoring tool. Nurse crops germinate quickly to cover an area while slower-sprouting perennials are still germinating. Wheat, rye, and oats are seeded in the fall to protect late seedings. Millets are used in the spring. Nurse crops can be applied too heavily, causing the annual nurse crop to inhibit the germination and growth of the perennials.

The use of optimum rates of lime and fertilizer is often prohibitive due to the poor condition of the dredged material, budgetary considerations, or transportation difficulties. Many species recommended for critical area stabilization have broad pH ranges, often as wide as pH 5.0-9.0. Required fertility levels can also be reduced by using legumes and native warm season grasses that are adapted to the site and proposed land use. The use of fertilizers with little or no nitrogen on initial applications for first year stands will give the plant the nutrients it needs and inhibit the growth of weeds indigenous to the site. Later applications of nitrogen will enhance the growth of established plants when they are dominating the indigenous species.

The application of herbicides is usually extraneous to critical area stabilization, and often in opposition to proposed uses such as wildlife habitat. Weeds can be a serious problem on critical areas such as dredged

material sites. Careful selection of herbicides and application methods and careful application by certified specialists can render maximum control and minimum environmental damage. Using granular materials or wick applicators rather than sprays greatly reduces the potential for off-site damage.

Selection of materials which target specific weed problems saves money and will leave desired plants alone. Herbicides are available which specifically control grasses and not broadleaved plants, control broadleaved plants and not grasses, control nonleguminous broadleaved plants and not legumes, or control germinating seeds and not established plants.

Rate and timing are also important. Certain rates will control the weeds with little runoff or residual. A higher rate will cause problems without improving control at all. Herbicide application must be timed not only with the weather but with the growth stage of the plant. A chemical to control germinating seeds often will not control even young seedlings. Chemicals designed to work on young plants often will not work on more mature plants. Few chemicals control plants late in the year when the plants are flowering and making seeds. Land uses such as parks and athletic fields where an aesthetic turf is important will necessitate herbicide use to establish good turf and landscape plants.

The bottom line of the SCS National Plant Materials Program is not only to select the proper species for the job and to manage them properly but to develop plant varieties and cultivars best adapted to a particular area of the country and soil condition. Widely adapted species such as switchgrass have a dozen or more cultivars each developed for a particular area of the country. Using the proper cultivar for each area will insure that you have the best "plant" for the job whereas using the wrong cultivar may confirm that a Texas switchgrass will indeed winter-kill in New York, or a Kansas switchgrass will die from disease in Florida.

There are 3,000 SCS field offices across the nation to assist with dredged material and fill stabilization. They are supported by 20 Regional Plant Materials Centers that are developing new technology for critical area stabilization and are aware of existing technology.

QUESTION: Would you elaborate on your experience in the Great Lakes on creating islands with sand for tern habitat, and what section of the WRDA addresses cost-sharing for migratory and endangered species?

MR. NELSON: Section 96E of the WRDA addresses migratory and endangered species cost-sharing. As far as the Great Lakes project is concerned, that process is ongoing, and the Detroit CE District and the FWS are working out the details. The project is in the Upper St. Mary's River near Sault Ste. Marie.

QUESTION: Several applications of dredged material you have discussed have had to do with commercial activities, foundation fill, and road maintenance. How is that handled with regard to property owners who own mineral rights and with regard to landowners' rights in general?

MR. NELSON: Most landowners have received the concept very well and have allowed stockpiling on designated sites. One problem has been making the dewatered dredged material accessible enough for proper utilization. Improved roads will help, and we think it is a good payoff for that investment. Mineral rights have not come into question.

QUESTION: How and why was GREAT established?

MR. NELSON: GREAT was established in response to pressure from states, and it was put together by the CE and the FWS. Until that time, there was a great deal of controversy over dredging and dredged material disposal. If I had a message to leave with this conference, it would be that in other areas there are similar conflicts. In the case of GREAT, the agencies were determined to solve the problem. In other areas with conflict, if we don't solve the problems at the field level, sooner or later somebody at a higher level is going to make us do it using something like the GREAT concept. The experience on the Upper Mississippi River should be well-taken by everybody.

QUESTION: Are you going to publish results of your CDF study?

DR. TUCHMAN: Yes, at the upcoming International Great Lakes Meeting, we will try to have a special session on CDFs. We should know by next month whether that will be possible, and we will plan papers at that time. We will give some results then, but I definitely will be eventually publishing results from the CDF studies.

QUESTION: Will you give an overview of the word "contaminated"? What is "hazardous"? How do you view this? What is contaminated and what is not? How do you classify these sediments?

DR. TUCHMAN: Well, to start at the top, if a sediment has PCB levels above 50 ppm, we call it toxic. We don't usually use the term hazardous. Toxic sediment is treated totally differently from any other sediment and is disposed of in special sites with special requirements. In the Great Lakes, a number of harbors (Indiana, Sheboygan, Ashtabula, Waukeegan Harbors, for example) are all toxic sites and are handled differently.

Polluted versus nonpolluted is determined by 1977 EPA guidelines for the Great Lakes harbors. It has guidance for heavy metals, organics, PCBs, and gives bioassay information. We try to build a broad picture of where this sediment fits into the scheme of things in the lakes. There is no set, cut-and-dried answer to determine one site over another as contaminated and requiring confinement.

QUESTION: Is the 205 funding that is available 60/40 cost-shared? Can the revenues derived from sale of soil be used as a local cost-share?

DR. TUCHMAN: Yes, it is 60/40, but I don't know the answer to the second question because I am not directly involved with the 205 Program. I can find out for you.

QUESTION: What are the critical levels in Toledo soils, and how do they handle them?

DR. TUCHMAN: Ed Hammett will be talking about that later in this workshop. They have basically clean material in their CDFs.

QUESTION: What do you consider a high lead content?

DR. TUCHMAN: We go by the 1977 EPA guidelines.

QUESTION: There is a lot of lake bottom habitat lost from CDFs. What kind of mitigation is required because of CDF filling?

DR. TUCHMAN: Theoretically, mitigation fulfillment for covering lake bottoms is the creation of the riprap dikes. These create waterbird habitat, provide shoreline stabilization, and create fishing reefs in the lake that were in short supply.

QUESTION: Do you know if Region 7 of EPA uses the same guidelines as the region handling Ohio and Missouri? Do the states you work with accept your 1977 guidelines? We have applied for 401 certification to states and encountered different requirements. Do the states use the same guidelines as you?

DR. TUCHMAN: Some states do and some don't. Illinois has its own guidelines based on their own 1979 studies on background levels. Wisconsin has just come out with many new numbers that are different from those of EPA. Our guidelines are just that---they are not law.

QUESTION: Have you had any problem with the spread of nonnative plants or have a contingency plan to prevent the spread of these plants?

MR. GLENNON: No. Are you talking about such plants as kudzu and multiflora rose? Kudzu is easy to get rid of. Guidelines are available although SCS is not trying to control kudzu. The worse problem with kudzu, as with crownvetch, is when it gets into trees. Then it is hard to manage. If it is kept in an agricultural situation, which is where it was intended to be used, kudzu is not a problem to control or eradicate. Most good managers don't let these special purpose plants get away from them. In the northeast, multiflora rose is only a problem where it has escaped or has been abandoned.

There have been new varieties of some of these species developed, for example, "Elgood" autumn olive, which is adapted to almost the same area as the old "Cardinal" autumn olive but does not have root suckering nor produce as many seeds. SCS has no organized eradication program---we just encourage good management.

QUESTION: Have you encountered concern for using agricultural crops on contaminated dredged material and any plant uptake from this material?

MR. GLENNON: There would be some concern, but I don't think we would plant agricultural crops on highly toxic sites or dredged material. EPA wouldn't let us anyway. The only danger with plants on contaminated sites is any possible accidental food use.

I wanted to give you a chance to identify your problems to our SCS offices. I have a sign-up sheet in back, and if you will leave your name, address, phone number, and information on your particular problem, I will have the nearest SCS Plant Materials Center or Specialist to your site get in touch with you. They should respond immediately. We have specialists in nearly every state.

QUESTION: You and several other speakers have mentioned using dredged material to build wetlands and shallow water habitat. I know that in the Great Lakes there have been shallow water sites with avian botulism problems. Is this unique to these sites, or is this a common problem on shallow water disposal sites? Is it widespread?

MR. MURDEN: I don't know the answer to that, and I will defer to Dr. Tuchman and Dr. Landin.

DR. TUCHMAN: I don't know if it occurs elsewhere, but the two sites in the Great Lakes have been managed to try to prevent a reoccurrence.

DR. LANDIN: There have only been those two recorded incidences to date in CE disposal CDFs in the Great Lakes. To my knowledge, no outbreaks have occurred elsewhere. Changing habitat types from mud flat and shallow water and the removal of ponded water has taken care of the problem in the Great Lakes sites so far. This is not a widespread problem. For example, there are over 30 CDFs in the Great Lakes, and botulism has only occurred in two of them in the 10 to 15 years since construction on the CDFs began.

## NON-FEDERAL INTERESTS AND VIEWPOINTS PANEL

### A PERSPECTIVE FROM THE PRIVATE SECTOR

Harry N. Cook, President
National Waterways Conference Inc.
Washington, DC

All too often, there are those who question on environmental ground the wisdom of periodic dredging of commercial navigation channels. Some would even go so far as to abandon barge navigation rather than dredge.

To those critics, I would point out that each transportation mode involves certain environmental impacts. For instance, the rights-of-way used by other surface modes of transportation are usually acquired by taking land away from other existing uses---recreational, residential, commercial, industrial, and agricultural and forestry. The supply of limited amounts of highly valued agricultural land in a region or nation may be diminished appreciably by the right-of-way acquisitions for these surface transportation facilities. Sometimes parks and other significant environmental holdings may be sacrificed to furnish the traffic corridors needed for a new rail line or a new highway or a new airport. Land use diversions are usually not associated with inland navigation, except in limited cases.

The navigation right-of-way is ecologically productive. It may be occupied by fish, birds and other forms of wildlife, canoes, sailboats, barges, fishermen, water-skiers, and other recreation seekers. That right-of-way in a naturally occurring, multiple-use resource, is in contrast to a rail or highway which is a man-made phenomenon created for the exclusive use of transport vehicles.

Studies by Booz-Allen and Hamilton Inc. and other research firms have established that water transportation is the safest mode of moving commerce. Without barges plying dredged waterways, substantially larger volumes of hazardous commodities would have to travel down heavily used highways and main streets and along railroad tracks through the centers of countless American cities and towns.

In comparison with other modes, water transportation generally requires less energy per ton-mile of freight, thereby producing less air pollution. The noise factor is minimal. Barges require less iron and steel per unit of cargo capacity. No woodlands have to be cut for crossties, no steel manufactured for rail, or any rubber processed for tires. These are all factors with environmental aspects.

When you consider that trade and commerce is the lifeblood of the American economy, you must realize that freight transportation is absolutely essential. The products of American farms, mills, mines, and refineries must move by one or more modes. And, to be sure, none operates in a vacuum. Transportation takes place in the real world. And water transportation, I submit, is the environmentally superior mode---the mode having the least consequences for the environment, particularly with respect to existing waterways.

Dredging has attracted a lot of attention in recent years, not so much as a result of the excavation process but as concern over disposal of the dredged material. This workshop is exploring all sorts of beneficial uses of this material---a recycling, if you will, in a constructive manner and in ways which have positive environmental effects. I think it is fair to say that the inland waterways industry strongly supports the maximum beneficial use of dredged material.

The only reservation that I would register involves economic considerations. The cost of beneficial use programs must be kept low and reasonable, regardless of who is picking up the tab. Because of deficit reduction at the Federal level, austerity programs throughout State governments, and near-recession in most waterway-related industries, frugality must be the order of the day.

Environmentally beneficial projects need not be expensive, and besides, they often produce significant direct and indirect benefits. In my view, beneficial use of dredged material merely accentuates the positive aspects of the dredging program, and I believe it warrants the support and encouragement of us all.

## NON-FEDERAL INTERESTS AND VIEWPOINTS PANEL

### A MAJOR INLAND PORT'S PERSPECTIVES ON BENEFICIAL USES

Donald C. McCrory, Director
Memphis and Shelby County Port Commission
Memphis, Tennessee

As far as beneficial uses of dredged material are concerned, with regard to the Memphis and Shelby County Port Commission, I want to concentrate my introductory remarks on the description and discussion of two major projects in the Memphis Harbor that have proven to be of great importance to local interests. It is difficult to trace the actual parentage of either of these projects; they may have resulted from a Federal program or from local proposals to the Federal government, but at this point in time, the Commission is not sure whose idea it was to plan and implement these projects. The Memphis and Shelby County Port Commission was created by special act by the Tennessee State Legislature in 1947.

### The Memphis Harbor

The first project is the Memphis Harbor. I'm not going to go into all of the authorizations required because it is not important to this discussion. I will point out a general time table. In 1947, a year before work on the new harbor began, river tonnage in Memphis totaled less than 2 million tons annually. With construction and development of the new harbor, now 35+ years old, tonnage began to increase and has continued to increase to the present time.

Construction of the harbor was part of project work under the Mississippi Rivers and Tributaries Act. The Tennessee Chute, site of the harbor, was a secondary channel of the Mississippi River. A dam, now known as the Jack Carley Causeway, was constructed in 1950-1951 at the head of the chute to provide access to President's Island and to provide an off-river, slack-water harbor. President's Island was elevated above the floodplain in 1957 through hydraulically placed dredged material from the harbor channel and now provides about 4 miles of harbor frontage and about 960 acres of choice industrial sites.

Statistics on the phased work are as follows:

a. The closure dam (1951).
Crest Length: 7,230 ft    Crest Elevation: 245 ft
Top Width: 100 ft    Volume of Dredged Material: 6,293,000 cu yd

b. Approach to closure dam (1950).
Crest Length: 1,850 ft    Crest Elevation: 243-248 ft
Top Width: 100 ft    Volume of Dredged Material: 300,000 cu yd

c. President's Island Industrial Fill (1957).
Crest Length: 21,000 ft    Crest Elevation: 238-240 ft
Area Built: 960 acres    Top Width: 2,000 ft
Volume of Dredged Material: 44,976,000 cu yd

These four additional miles of shoreline and 960 acres of land added to the Memphis Industrial Harbor nearly doubled the amount of space available for industry over land available in the early 1940's.

I want to emphasize here the planning and the purpose that went into this latter portion of the harbor project. While the initial phase (construction, design, and engineering) was done by the Memphis CE District, local interests (the City of Memphis and Shelby County) cooperated in the project by providing without cost all lands, easements, rights-of-way, and dredged material placement sites necessary for construction of the project and all subsequent maintenance of the harbor. Local participation also includes development of the industrial area by providing streets, sewers, public utilities, public terminals, and rail facilities.

Memphis Harbor now provides an off-the-river, slack-water harbor, free from flood velocities and floods, and offers protected industrial sites with direct access to low-cost waterborne transportation which connects with land transportation facilities. The harbor channel is maintained at 12 by 300 ft. Total Federal costs were $19,000,000. Local interest costs, with land provision and the above named improvements including the public terminal and the rail system, were at least 50 percent of the Federal costs.

We will be adding an additional 1,000 acres to the available industrial sites in Memphis that are cost-shared. This project is a part of the WRDA.

## Mississippi River Stabilization from Loosahatchie to Memphis

The second project I want to discuss was initially referred to as stabilization of the river from Loosahatchie Bar to the City of Memphis, between RM 735 and 740. In the early 1960's, plans for construction of interstate highways through Memphis called for a new bridge between Arkansas and Tennessee. The location of this bridge called for channel realignment in the area. The addition of another bridge just 2 miles above existing river bridges in Memphis, without realignment, would have created an extreme and intolerably unsafe river navigation condition for large barge tows.

This realignment required that the stabilization line, or new east bank on the Memphis side of the river, be moved back approximately 1,500 ft inland. In December 1963, a decision was made to complete the channel realignment by late 1968.

The realignment plan called for removal of about one-third of Mud Island and involved about 33 MCY of excavation. Stipulations were that there could be no appreciable interference with navigation in the main channel while realignment was being done, that there be no delays due to high water, and that scheduling and placement provisions of dredged material had to be made accordingly. Such a large amount of dredged material could not just be dumped into the river without serious impacts, and dredged material could not be pumped to the west side of the river without closing the main channel to navigation.

A two-phase dredging plan was developed. In Phase I, a pilot channel 30 by 400 ft was dredged along the new east bank alignment. After this was revetted, navigation was routed through this temporary channel. The material in this first cut was placed on or near Mud Island.

In Phase II, all remaining land west of the pilot channel was dredged. While the pilot channel was being used for navigation, all dredged material from the remaining area was pumped across the river into a placement site on the west bank.

Mud Island was a placement site provided by the city of Memphis. The city of West Memphis, Arkansas, was responsible for the west bank placement site. The Mud Island site provided 400 acres of land above flood stage adjacent to downtown Memphis. The dredged material actually raised Mud Island to about 20 ft above flood stage. With the cooperation of local interests, acquisition of real estate easements and diking took place in 1964-65, and the pilot cut was begun in March 1965. The new channel was completed in October 1966, and Phase II dredging was completed in August 1967.

Project statistics included placement of 33 MCY of material, 4 miles of new revetment, 5.7 miles of new dikes, and an approximate total cost (both Federal and local) of $15,000,000. This project provided a stable navigation channel on an improved alignment for navigation under four Memphis river bridges. Other benefits included approximately 520 acres of flood free land on and adjacent to Mud Island that had not been accessible to the city for development. In addition to the development of the Mud Island complex, which included a river museum, restaurants, a model of the entire Mississippi River, and other features concerning the river, various proposals for additional development include a combination of educational, recreational, light industrial, and urban residential beneficial uses that have been implemented or are under current consideration.

This all came about because of the interstate highway system and the continued cooperation between the Memphis CE District and the Public Authorities of Memphis and Shelby County.

## Summary

We have found that having a firm objective, a plan of action, and good leadership is the best approach to successful completion of projects utilizing dredged material beneficially in our harbor. Cooperation in planning projects that have long-range benefits cannot be overemphasized.

The Memphis and Shelby County Port Commission works hand-in-glove with not only the Memphis CE District but all agencies both Federal and State to help in our long-range planning efforts. We try to keep not only our local interests in mind but those of the entire river community and nation as well. Thank you.

## NON-FEDERAL INTERESTS AND VIEWPOINTS PANEL

# A STATE NATURAL RESOURCE AGENCY PERSPECTIVE ON BENEFICIAL USES

Richard S. Bartz
Division of Water Ohio Department of Natural Resources
Columbus, Ohio

I have been asked to give the perspective of a natural resource agency on beneficial uses of dredged material. We have been involved in several types of beneficial use projects, some of which I will review for you. These projects include private, public, and local and State government projects. Our coordinator for dredging at state lakes estimates that about 70 percent of the material dredged in the lakes goes to one or more beneficial uses. Some of these include development of native prairies, recreational facilities, wetlands, and shallow water habitats.

There are eight commercial and four recreational harbors dredged by the Buffalo CE District along the Ohio shoreline of Lake Erie. Most of the commercial harbors are maintained at 28 ft deep. In 1986, 2,047,799 cu yd were dredged at Ohio harbors. Toledo Harbor alone was responsible for over half this volume (1,237,612 cu yd). Depending upon the harbor and the quality of the sediment, most maintenance dredged material is either disposed of within the open lake or in CDF's.

I should note that my work involves Lake Erie and the Great Lakes. I have not been involved in Ohio River projects so I cannot give you a perspective on river dredging and beneficial uses. Also, Ohio has not been involved in these river projects because our jurisdiction ended at the banks of the river. Until 1984, Kentucky claimed all of the Ohio River. Pursuant to a US Supreme Court case, Ohio boundaries now extend partially into the Ohio River. The only beneficial uses of the river material of which I am aware include pumping sand onto beaches, upland disposal (fast land development), and disposal into tailwaters downstream of dams.

Ohio's position on beneficial uses is that overall, we support exploring such alternatives. However, there should be remedial values to the body of water where the material would have to be disposed in such a manner as to provide some beneficial shoreline or upland use or to add habitat in order to justify the alternative cost. We encourage upland disposal, use as agricultural enhancement, wetland creation/restoration, etc. However, we must appreciate that the economy of our cities and our state is linked to our ports and that our ports must be dredged. Beneficial uses must complement our port activities.

One of the areas in which we have been working with the CE and other public and private interests is nearshore disposal of sand dredged from channels. Ohio requires sand and gravel resources from dredging projects be returned to the nearshore area. We have been successful in enforcing this with non-Federal interests but have not been as successful with Federal CE projects.

The reason we are interested in nearshore disposal of sand is because sand beaches are the best form of natural shore erosion protection. The Ohio shoreline has a deficit of sand in the littoral zone. Large Federal projects may trap large quantities of sand; for example, 70,000 cu yd/year at Fairport Harbor alone. The downdrift of such structures has accelerated erosion rates so it makes sense to return sand trapped in Federal channels to the nearshore area to reduce shore erosion and recession.

Ohio's limited success with the CE revolves primarily around one question: who pays for increased costs involved in nearshore disposal? With non-Federal interests, we just require them to do it. It's not so easy or straightforward with the CE. CE policy on paying increased cost for beach nourishment with sand is found in PL 94-587, Section 145. Prior to the WRDA, non-Federal interests had to pay 100 percent of any increased costs for beach nourishment. Now non-Federal interests only pay 50 percent of the increased costs.

We were very encouraged when the CE was directed by Congress to pay 50 percent of the increased costs until we saw the guidelines for Federal participation. Briefly, they are: (a) added costs must be justified by the benefits associated with the protection of the beach; (b) storm damage reduction benefits must exceed 50 percent of total benefits; (c) the beach in question must be open to the public; (d) local interest groups must provide necessary easements and rights-of-way; and (e) funds needed for the added Federal costs must be included in the Federal budget in advance. In emergency conditions due to erosion, funds may be made available if there will be no adverse effect on other scheduled CE activities.

The above guidelines make it extremely difficult to obtain CE participation in beach nourishment projects and are contrary to the intent of the law. Ohio hopes to work with its Congressional delegation and other states to get this changed.

Right or wrong, Ohio has a basic problem with paying the increased costs. CE projects are trapping and interrupting the littoral drift, which results in downdrift damages. So, we are trying to work toward getting the CE to pay for all the costs of nearshore disposal just as any other public or private project must do in the State of Ohio.

Ohio has asked the CE to conduct Section 111 studies for most Ohio harbors in Lake Erie. One has been completed at Cleveland Harbor where the CE has assumed all costs for nearshore disposal. The CE has started two additional studies at other harbors. We expect the CE studies to find that subsidies for the increased costs of nearshore disposal can be justified. For example, at Fairport Harbor, the CE may pay up to $2.17/cu yd in increased costs for nearshore disposal, so Ohio is at least making some progress toward solving this funding problem.

Another challenge is the time frame in which non-Federal interests must provide their share of the funds of increased costs on Federal projects. The CE is not able to tell us in advance how much additional cost there will be because they do not know until the bids are opened. Before the contract is awarded, we are required to give the CE the state's share of the funds within

2 to 3 weeks of bid opening. It is extremely difficult for us, and even worse for small local governments, to deliver a check in 3 weeks and, therefore, to participate in nearshore disposal.

We are also encouraged by Section 1154 of the WRDA, which requires the CE to consult and cooperate with concerned Great Lakes states in selecting disposal areas for dredged material which are suitable of beach nourishment. This has been another challenge for us. In the past when we asked for nearshore disposal, the CE told us that it was not able to comply because a nearshore disposal area had not been designated pursuant to Section 404(b)(1) guidelines and the public had not been notified. These requirements prevented beach nourishment at two Ohio harbors. In keeping with the spirit of Section 1154, we have asked CE to conduct any needed environmental studies and to designate certain nearshore disposal areas. We, in turn, have provided the CE Districts with proposed disposal sites. To date, three areas have been designated, and two more will be shortly. In response, we are required to furnish evidence of the presence of sand. Further, we are asked to determine exactly how much sand is needed. Ohio's position is that the long-term impact of removing small quantities of sand every few years into a littoral environment that already has a deficit of sand must be considered.

Another challenge is to determine how close to shore is close enough for nearshore disposal or beach nourishment. Our geologists tell us that the maximum depth needed for any material to move shoreward is 12 ft deep. A hopper dredge with a full load of dredged material often requires 18 to 20 ft of water. In more shallow areas, contractors must carry partial loads which increase costs substantially.

While I have talked about a number of challenges that Ohio has had to deal with to accomplish nearshore sand placement, I want to emphasize that we have had several successful projects with the CE of nearshore sand placement in Ohio. We look forward to working with the CE in the future on additional projects and overcoming these challenges.

Another beneficial use project where Ohio has been involved is Toledo Harbor. We are exploring ways to reuse approximately 600,000 cu yd of material each year instead of using open lake disposal. This material consists of fine silt and clay. Several alternatives are being discussed, such as wetland creation, island creation, strip mine reclamation, commercial topsoil, golf course fill, and a recreational fill. I look forward to Ed Hammett's presentation tomorrow where he will address this project and potential beneficial uses.

Lastly, I would suggest that we start thinking of beneficial uses when designing CDFs. The CDFs were mandated by Congress to hold sediment too polluted for open lake disposal. Most CDFs in Ohio were constructed without regard to future land uses. In any discussion of beneficial uses of dredged material, we should consider beneficial uses of CDFs. The current CDF designs lack creativity for any future intended use. With competing demands for shorefront property, new land created by CDFs should be assets and should have multiple uses. We have been told that the CE can only consider navigation benefits in the benefit-to-cost ratio. We as states need to work with Congress so that future use of sites, i.e. future land use benefits, can be

considered in the benefit-to-cost ratio when CDFs and other disposal sites are planned and designed. Otherwise, we may continue to have large islands that are underdeveloped or that have little or no access to the public.

## NON-FEDERAL INTERESTS AND VIEWPOINTS PANEL

# A STATE DEPARTMENT OF TRANSPORTATION'S VIEW OF BENEFICIAL USES

Daniel A. Injerd
Division of Water Resources Illinois Department of Transportation
Chicago, Illinois

I welcome the opportunity to come here and talk to you about the perspective we see for beneficial uses of dredged material in Illinois. Frankly, this is my first conference on dredging. I have been very surprised at the level of interest in beneficial uses. In our experience, this is a rather recent phenomenon, but as I look back at the history of Chicago, Chicago is probably one of the first major Great Lakes cities to put dredged material to beneficial use. Much of the Chicago shoreline actually consists of dredged material. This was something I was not aware of when I first came to Illinois, but in fact, a major portion of the whole Chicago lakefront was built by the city from hydraulically pumped dredged material in the 1920's.

However, as the environmental movement in the Great Lakes gathered momentum, dredging and disposal became dirty words, at least in Illinois. Anytime you mentioned dredging, it "raised the fur" of environmental groups. Disposal in the lake was really frowned upon.

When the Department of Transportation first got involved in the 1970's, we were looking at a shoreline in disrepair and were suffering major erosion along the lakefront. Our first State requirement was that anyone wanting to remove clean dredged material from a harbor entrance channel could not sell the sand but had to retain the sand in the nearshore environment. The states in the Great Lakes are trustees of the lakes, and it is a responsibility we take very seriously in Illinois. We try to influence policy at both a state and a Federal level where the lakes are concerned.

In the 1980's, we realized that CE dredging projects had potential for beneficial uses. A good example is Waukegan Harbor, an old turn-of-the-century harbor that extends far out into the lake and has trapped large quantities of sand. The established disposal area for that harbor is three miles offshore, and in the early 1980's, we talked to Chicago CE District about nearshore disposal. We have run into the same problem that Ohio has in that once everyone has agreed to an accepted disposal area, the CE is very reluctant to go back and try to change that agreement. However, the Chicago District agreed to receive bids on both a nearshore site and the 3-mile offshore site. We found the nearshore site to be less expensive than going to the offshore site. In 1984, the Chicago District completed the first nearshore project, disposing of 86,000 cu yd. The project was done by private contract in 0 to 12 ft of water. Our US Congressman was also very supportive of the project, and in fact, Illinois Congressional representatives have been very active in helping us with these types of efforts.

Today our basic position on beneficial uses of dredged material is quite simple. If dredged material is clean sand, it is required to be deposited on shore or in the nearshore zone for beach nourishment and shoreline stabilization. This is mandatory state guidance. The state owns the submerged bed of

the lake, so the sand dredged up belongs to the people of Illinois. It is a resource to be used by the state, in our opinion. If it is clean sand, we want it used for public benefit.

One of the things we have done recently is to construct sand traps for shoreline stabilization and erosion control. We try to be consistent, and we require that if anyone puts out a groin or other structure that will prevent sand movement, that they bring in sand some way to add to the lake system.

We can't ignore private dredging. For example, Commonwealth Edison has two power plants on Lake Michigan. They had to dredge their intake areas (85,000 cu yd) in the 1980's. The dredged material turned out to be entirely clean sand. A nearby state park was experiencing severe erosion 3 miles away, and we arranged for Commonwealth Edison to put the entire amount along the park beaches. At a time of record lake levels, Commonwealth Edison added 100 ft of beach width to the park. Not only did this help stabilize the shoreline, but it generated a lot of good publicity for the power company. We expedited our permit process for this project and would like to see more like this one in the future.

One other example I would like to point out is that we also have some CDFs that are under construction or in planning stages, and we share many of the concerns Dick Bartz expressed. We added a requirement that since CDFs in Lake Michigan will take part of the submerged bottom that belongs to the people of Illinois, local public ownership would be permanently assured upon filling and completion of a CDF. This requirement has caused no problems, and the CDFs will provide a continuing public use. This will help mitigate the loss of lake bottom and any potential problems with a CDF.

Earlier speakers who talked about negative attitudes towards disposal activities were right on target, at least in our area. There are two issues I would like to bring up for further consideration at this conference. One involves public education, and the other concerns economic analysis.

The education process concerning dredging and dredged material disposal needs attention outside a professional meeting such as this one. The general public needs to be made aware of beneficial uses. We as agencies continue to have problems with public and environmental group perceptions, who often express genuine concern. In meetings with these people, they always talk about "spoil" and contaminant levels, and beneficial use is a hard concept to sell in the Great Lakes for public waterways. The CE has done an excellent job in looking at beneficial uses and dredging technology in detail, but somehow we have all missed the boat on public education.

As an example, rapid shoaling of the Waukegan Harbor entrance channel required additional dredging just 2 years after the initial dredging where nearshore disposal was used. This time, however, the negative perception of Waukegan Harbor (sediment within the inner harbor has high PCB concentrations) prevented local interests from receiving the benefits of nearshore disposal. Although the source of the shoaling (littoral drift fine sands) was the same as before, our state water quality agency imposed a highly intensive monitoring program as a condition of approving nearshore disposal. This requirement was unacceptable to the CE and resulted in a considerable delay in performing

this dredging. Although ultimately nearshore disposal was approved (additional tests confirmed the sediments were clean), it does illustrate the need for better education on beneficial uses of clean dredged material.

Second, the economic analysis issue is still a problem for all the Great Lakes States. As Dick Bartz pointed out, it is very difficult to pinpoint economic benefits of nearshore disposal in a benefit-to-cost ratio. At Waukeegan, the dredged material was fine sand, and it moved on fairly rapidly through the lake littoral drift system. The benefits were certainly there but, as with most beach nourishment projects, can be fairly short-lived. We need to take a more positive look at economic benefits so we can better justify beneficial uses.

One more thing I wanted to say is that it is essential that the CE allow nearshore disposal to become routine and in the Great Lakes to be integrated into existing programs so each project won't be such a tremendous coordination effort. Being in the Department of Transportation, as a member of a large State agency, I know that coordination just within the agency can be difficult. However, the beneficial use opportunities are out there, and we all should be taking advantage of them. I can foresee that beneficial uses can ultimately reduce the cost of dredging, especially where we are doing beach erosion control. Thank you.

## NON-FEDERAL INTERESTS AND VIEWPOINTS PANEL

# A STATE REGULATORY VIEWPOINT ON THE BENEFICIAL USES OF DREDGED MATERIAL

Paul L. Hill, Deputy Administrator
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Charleston, West Virginia

The State of West Virginia is very much interested in the beneficial uses of dredged material from our rivers and streams. We know the potential of this resource. The state has no natural lakes, with the exception of the very small Lake Louise. Our situation therefore contrasts greatly with the terrain here in Minnesota. There are no large-scale projects like Weaver Bottoms in West Virginia. Thus, all dredging activities occur in the major navigational basins of the Monongahela, Big Sandy, Kanawha, and especially, the Ohio Rivers.

There are four basic categories of beneficial uses we have observed when certifying dredging permits or determining the placement of dredged material. These are probably beneficial uses most of you have considered, but we have prioritized them in order of the way our agency would prefer the use to be. These priorities range from aquatic habitat development at the top of the list to upland fill at the bottom.

Uses, as you are aware, depend to a great degree upon the source or substrate characteristics. For example, if the material is rock or cobble, usually a scarce commodity, it can be used for aquatic habitat development, our State's highest priority. In these cases, we attempt to develop underwater reefs or shore structures to improve fish habitat. Also, materials of this nature have been used for fishing jetties and access sites to improve access to fishermen.

If the substrate is sand, a recreational use is usually made of the material, our State's second priority. Beach and island developments are the most common uses. We recently observed the development of a new city park near the State Capitol, constructed for the most part from sand dredged from the Elk and Kanawha Rivers.

When the material is muck, silt, or clay, we have not been as successful in applying beneficial uses. Although we would consider upland habitat enhancement our third priority, few landholders or permittees have stepped forward to utilize this material. This is due to the fear of heavy metal contamination or the presence of toxic organics. As a general rule, this type of material is used as fill for the sake of fill, our lowest priority. In a state with very little flat land, the opportunity to place dredged material provides unique opportunities. Filling of ravines is usually greeted with enthusiasm by local and private interests.

Recently, we have been investigating two new applications of this material in West Virginia. A surface mine owner has used Ohio River dredged

material to establish an artificial wetland to treat acid mine drainage. Ideally, river soils will improve and, in fact, have improved the growth of cattails and other wetland plants at the site. The site holds great promise for the treatment of a serious environmental problem in our state with the mining industry.

The other application is the placement of dredged material on surface mine sites to promote vegetation growth and reclamation. We are aware of the feasibility of this technique but to date do not have any sites utilizing dredged material for this purpose.

Overall, I must say that we currently have a very low percentage of dredged material being put to beneficial uses. Most is stockpiled in disposal sites and sometimes used at a later date. As miscellaneous uses, we have dredged sand being used for winter highway maintenance and a recent project that proposed to recreate a mussel bed. Not only will the mussels themselves be moved, but the gravel bar where they occur will also be transported across the river from their present site. This project has not been approved and is presently under review.

An additional project involves enhancement of an existing wetland by diking with dredged material. This will increase water storage and greatly increase the size and stability of the wetland.

As someone mentioned previously, many of the speakers, myself included, stand here and use the word WE. This word means far more than any particular agency. Obviously, without the cooperation of EPA, FWS, and the CE, my agency could accomplish very little in this area. Therefore, credit is given where credit is due. Marc Tuchman pointed out this morning that EPA's role in dredging activities is usually just regulatory. My office also carries out a primarily regulatory role. Our various divisions do, however, have broad interests in this activity as it relates to land management, endangered species protection, and wildlife habitat improvement.

The West Virginia Office of Regulatory Affairs looks forward to working further with the various coordinating agencies, and I feel we can accomplish improved beneficial uses in the future. Thank you.

COMMENT (MR. MURDEN): We have in the CE a group of specialists in coastal engineering at WES. Dredging and coastal engineering is intertwined. It is a widely held opinion that fine-grained dredged material is worthless for beneficial uses in marine coastal environments. However, in a project we did five years ago off Norfolk, VA, using fine-grained material, we placed the material in a nearshore zone and achieved 7 to 13 ft of mounding, something we have never considered before. These mounds acted as offshore breakwaters. Three hurricanes have hit them, and they are still there. The long-believed position that fine-grained material is worthless is not true.

Since the 1940's, we have also placed beach-quality sand in 40- to 45-ft-deep water off New Jersey, Florida, and California to act as breakwaters. We have built 20-ft-high berms in 40 ft of water, 3 miles long, to serve as hurricane protection. I think this is applicable in the Great Lakes. Also, we have found that dredged material does not always have to be placed in the nearshore zone to effectively serve as shoreline protection. Large hopper dredges with deep drafts are the coming thing in the dredging industry, and they can work in 18 ft of water.

MR. INJERD: I would certainly agree that fine sand and fine material is a resource. There is no question that if we were designing a beach nourishment project, where we were specifying sand from an offshore source, we would specify larger grain sizes because it will stay on the shore longer. However, if it happened that fine material has to be moved, we'll certainly take it. I am not sure how much the underwater berm concept would be of use in the Great Lakes. In Chicago, the shoreline is armored, and just offshore the water is 12 to 15 ft deep. We take a lot of storm damage with 12-ft waves over a short period of time. We believe we need the material as close to the surf zone as possible to trip those big waves as they start to break before they can hit the shore.

Our state park project has survived the lake high-water cycle, and we prefer to put material there on the shore rather than in deeper water.

MR. BARTZ: Not being a coastal engineer, I don't know how the Great Lakes compare to coastal areas. I do know that our offshore disposal sites vary in depth from 20 to 30 ft. We have put great quantities of material in them, some of which even came out of the water. It just doesn't move toward shore or provide much shore protection. I believe that the closer to shore the better in the Great Lakes.

MR. MURDEN: I don't think anyone has all the answers. That is why the CE is conducting two national demonstration tests in the Gulf of Mexico off Mobile Bay, AL. The only way to know is to do a project and document what happens at various depths in the Great Lakes. These two large, expensive tests at Mobile are the first in the world in which extensive documentation is occurring. We are taking these tests, plus the earlier projects I mentioned on the Atlantic coast, and building a case for underwater berms. The CE is doing yeoman's engineering work on this concept, and I am asking you to keep a close eye on that.

QUESTION (DR. LANDIN): Surface mine reclamation incorporating wetland development was mentioned in West Virginia. Has this type of effort reached a

point of being actively and routinely considered by the surface mine owners, the CE Districts, and the state agencies within the Ohio River Valley? This certainly is an area with opportunity---to use dredged material for wetlands on surface mine sites. How will cost-sharing affect this beneficial use application?

DR. HILL: No, it hasn't become routine. Our site was an experimental one. At that site, the mine owner was dealing with a lot of clay that would not allow vegetation to establish. He also happened to have a dredging permit for another area, so he brought the sandy dredged material from the other site, mixed it with the clay, and established a cattail wetland. We haven't progressed beyond this project.

QUESTION: Do you intend to?

DR. HILL: Yes, everyone in the state is very much interested, especially the mining people. After West Virginia okayed the wetland site, the reclamation people got a lot of requests from coal operators to be allowed to build artificial wetlands. Everyone looks at it as a panacea to solve the acid mine drainage problem. Unfortunately, the site is 1 year old, and it hasn't proved as successful as we had hoped as far as treating mine drainage. The cattails and other colonizing wetland plants are growing beautifully, and the iron and manganese levels have been cut dramatically, but we still haven't gotten them down to State standards.

DR. LANDIN: Maybe this is a ripe area for research in the Ohio River Valley.

DR. HILL: I agree with you. In fact, we have some graduate students at West Virginia University who are looking at this particular wetland site.

QUESTION: You said people own the clean sand on the Great Lakes bottoms. Who owns the contaminated stuff?

MR. INJERD: We don't own that!! Seriously, we are fortunate in that the material in Lake Michigan is almost always clean sand. No more than 20 percent can be other than clean sand, or we require special analyses of the material. Generally, contaminated material is inside the harbors, and it generally goes to designated, specially designed CDFs. Fortunately, we don't have to worry too much about who gets the contaminated material anymore.

QUESTION: You mentioned financial constraints in Ohio. Is this a problem in other states under austerity programs? Does this hinder innovation in using dredged material within your states?

MR. BARTZ: We have just been requiring nearshore disposal in the past few years, and we don't have funds for cost-sharing in Ohio. We have difficulty convincing our Ohio Assembly that they need to budget funds for this. Since shore erosion is such a hot media issue right now, we are hoping to capitalize on this and to get cost-sharing funds in the next budget for nearshore disposal projects.

QUESTION: Dr. Hill, you were talking about sand for highways. Were you talking about sand in lieu of salt for winter weather or fill material?

DR. HILL: This is really a minor use in West Virginia, but it is used from dewatered sandy disposal sites for fill material by private groups and by counties in lieu of salt.

QUESTION: Is your definition of clean material the same as EPA's?

MR. INJERD: Our first criteria is grain size. Sand size or larger is considered clean. Smaller size particles are suspect.

MR. BARTZ: Our general rule of thumb is that any dredged material that is 80 percent sand is clean. It also depends from which harbor it comes. Some are worse than others.

QUESTION (MR. JOHN WOLFLIN): You describe two stillwater harbors in Memphis. In the construction of these harbors, are you aware of any consideration given to the public's interest in fish and wildlife?

MR. McCRORY: In terms of local interest, some recreational use has been made. With fish and wildlife, that's another story. The wildlife habitat there is outstanding, and that causes us problems with trespassers and poachers. Deer, turkey, game, and nongame animals are plentiful. We are reluctant to let the Tennessee Ornithological Society out there for fear that they will try to stop future harbor development, which has happened in other areas of the country. In the past two years, an industry at the port was sold with part of the land transaction designating part of the site that stuck out into the lake for wildlife purposes. I think that was to satisfy complaints from environmental groups. As a port and as a county, we have not officially addressed this question.

QUESTION (MR. WOLFLIN): The first harbor you developed was in the 1940's and the second was in the 1960's. These two harbors were "grandfathered." Will fish, wildlife, and wetlands be considered in your future development?

MR. McCRORY: In view of the expansion project we are doing now, an EIA has been prepared considering fish and wildlife, wetlands, archaeological values, etc. I have a lot of pressure from hunters who want into our 2,000 acres of bottomland hardwoods. We are developing a plan for bottomland hardwood management that includes fish and wildlife, but we don't intend to allow hunting. We consider it dangerous this close to Memphis and in developed industrial areas. President's Island is not visible to the city of Memphis except from the air, but it is in the city limits, which by law forbids hunting and firearm discharge. We also have 4,000 acres of agriculture leases on part on the port property. We stipulated that there will be <u>no</u> hunting of any kind and no commercial fishing.

COMMENT (DR. LANDIN): President's Island is a prime nongame habitat as well as a game area. In monitoring that vicinity for several years, I have found a large heronry and tremendous overwintering and migratory use by waterfowl, waterbirds, and other nongame birds. Deer populations are very high. Recreational fishing use is also very high. Don McCrory can tell you that the Memphis Audubon Society keeps a careful eye on President's Island.

COMMENT (MR. WOLFLIN): That doesn't surprise me at all. In fact, that very habitat is a beneficial use of dredged material if the port wants to take credit for it.

COMMENT (MS. CAROL COCH): New York CE District has a 6-ft-high feeder berm project that was done because the local sponsor couldn't come up with an immediate cost-share for beach nourishment. We put the material in 15-ft-deep water for a length of 2,000 ft using a hopper dredge and are monitoring the project with WES to see what material moves onshore. Results should be available in 1988.

QUESTION (MR. HOLLIS ALLEN): The CE has demonstrated that it can stabilize shorelines with vegetation behind temporary breakwaters, mostly in coastal areas. Have you considered this type of stabilization in the Great Lakes? It would combine stabilization with wetland habitat.

MR. BARTZ: Ed Hammett will address this later. We had looked at this at Woodtick Peninsula. Our problem there has been finding effective breakwaters because it is a high erosion area. However, most harbors in Ohio don't lend themselves to this type of stabilization using wetland plants.

MR. INJERD: We have the same problem in Illinois with three unique factors. Half our shoreline is in the Chicago city limits, and much of the rest is steep natural bluffs overlooking the lake with the rest in a state park of sand dunes. The city and State are looking at stabilization using offshore breakwaters, islands, stabilizing foredunes, etc., but they are looking at a billion dollar price tag, and it probably won't happen. Fill material, not dredged material, is one of the least inexpensive sources of construction material. They are even looking at using potential super collider tunnel material for this should Illinois get the nod from the Federal Government for that project.

COMMENT: I just wanted to congratulate everyone involved in this conference. I am a construction surveyor and have worked on dredging projects all my life. I am also a member of the Upper Mississippi Waterways Association, which has to make use of the navigation channels you maintain, and I commend you for finding good uses for this dredged material from the channels.

## SESSION I: AQUATIC HABITATS

### OPENING REMARKS

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Welcome to the first technical session. The subject of this session is the beneficial uses of dredged material to create or enhance inland aquatic habitat. Other more commonly know beneficial uses of dredged material include beach nourishment, landfills, levee construction, and use as soil conditioners. If the dredged material meets engineering specifications, it could also be used in concrete, in asphalt surfacing mix, and in highway ice control.

We can define inland aquatic habitat development as "the establishment of biological communities on (or using) dredged material placed in permanent waters of lakes or rivers" (USACE 1986). Known historical uses of dredged material for aquatic habitats include the creation of gravel riffles, mussel habitat, and artificial reefs. In these instances, the particle size of the dredged material will often limit its potential uses for aquatic habitat. For example, mussel habitat may require a certain size of substrate particles. The size will be determined by the habitat requirements of the targeted mussel species. The construction of artificial fishing reefs generally requires large rock which is not available from normal maintenance dredging but may be obtained from new work dredging.

There are many environmental and logistical issues which must be resolved in attempting to create aquatic habitat. Knowledge about practical techniques for development of aquatic habitats and about the expected success of such projects is limited but growing. Contaminant of dredged material will generally exclude the material from use as aquatic habitat because of the potential for bioaccumulation of the contaminants. Potential changes in flood heights or in river currents may limit the use of desired disposal sites. Trade-offs between the values of habitat created used dredged material, and the habitat displaced by the dredged material must be determined.

Dredged material placed in waters of the United States must meet the requirements of Section 404 of the Clean Water Act. This generally involves obtaining a permit from the CE or from a state which has assumed the permit program for non-navigation waters. At this time, Michigan is the only state to have assumed the program. Joint responsibility for evaluating the discharge of dredged material under Section 404 is shared by the CE, or approved state program, and by the EPA.

Aside from the basic environmental concerns for the discharge of dredged material, regulatory agencies must consider logistical issues. A determination must be made on whether maintenance of the site will be necessary. If maintenance is necessary, who maintains the site and for what period of time? Will the site need to be actively managed? What are the costs, and who will provide the funding? Long-term monitoring of a site may be necessary to

determine what natural changes are occurring and whether the site is functioning as designed.

The following presentations will provide some of the latest information on potential uses of dredged material for aquatic habitat creation and enhancement. An overview of various techniques will be followed by some case histories of actual projects.

## References

US Army Corps of Engineers. 1986. "Dredged Material Beneficial Uses," Engineer Manual 1110-2-5026. Office, Chief of Engineers, Washington, DC, 297 pp. + app.

## SESSION I: AQUATIC HABITATS

# AN OVERVIEW OF USES OF DREDGED MATERIAL TO IMPROVE OR CREATE AQUATIC HABITAT IN INLAND WATERWAYS

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Let me differentiate our beneficial use area from the wetlands that you will hear about later. We are talking about building aquatic habitats in navigable waterways, that is, putting dredged material below the surface of the water for habitat development. There's not much to photograph because all the action is below the water in rivers and lakes. This is an area that is near and dear to my heart and that we have been working on since the early 1980's. Most of our funding has come from Mobile and Louisville CE Districts because of their interest in riverine beneficial uses. There has not been a lot of study in aquatic habitat development using dredged material, but that is not because the opportunities do not exist.

By way of introduction, let me talk about the material available for habitat development---anything from fine silt to cobble. Each substrate type has its own particular uses and challenges. In an aquatic situation, the coarser-grained material is more valuable and will stay in place better. Fine-grained material does have value for aquatic organisms, and in addition, it can be used as a base for coarse-grained material.

Let me also mention briefly a study that we conducted in south Mississippi in which we took benthic and clam samples in a stream with various amounts of gravel. We found that as the percent of gravel increased, the percentage of clam occurrence and numbers increased. There are two reasons for this: (a) the gravel provided a more stable substrate; and (b) the gravel provided a variation in the stream bottom that attracted clams and other aquatic organisms. This demonstrates the value of gravel for aquatic organisms.

Riprap is not a traditional dredged material, but it is often used in conjunction with dredging. Habitat development is often associated with riprap in a river system, and it is a very valuable habitat feature. We have tended to overlook this in the CE. The value lies in the interstitial spaces between the stones where organic matter and benthos can accumulate. Fishes are attracted to these features, and whether riprap is used along a shoreline or for wing dikes, both become very valuable aquatic habitat.

For example, I was investigating a site in Memphis CE District for freshwater mussels and was amazed to find tremendous numbers of mussels down in the riprap among the stones. I found up to one mussel per minute compared to one mussel every 5 to 10 min in the adjacent smooth mud bottom. These numbers may not sound like much to people unacquainted with riverine aquatic habitat, but I can assure you those are very high densities.

To summarize my overview, I want to reiterate that coarse-grained material traps sediment and fine particles of food for aquatic organisms. The stones serve as attachment points for algae and invertebrates, and they provide stability for fine-grained sediments. Stones and other coarse-grained material also attract fish. This includes material all the way from sand up to riprap.

We have been working on aquatic habitat for 6 to 7 years, and in general, I have four reasons for being excited about our studies. First, we are at the cutting edge of technology development for aquatic habitat development. These techniques are usually not easy and take specialized thought. Second, we are developing techniques for sampling and monitoring in aquatic habitats, an area that is usually quite costly due to the problems of working in underwater environments. We have found, for example, differences in organisms from sample period to sample period just due to substrate consolidation on newly created sites.

Third, we have found high public interest in aquatic habitat projects. Jack Mallory and Robert King are going to talk to you next about a gravel riffle bar we created in the Tombigbee Waterway that has stimulated tremendous interest by the public and the media. Bruce Stebbings and Robert Kanzinger are going to follow with a discussion of a site we created in the Ohio River as the result of a private mitigation action that has also stimulated attention in the Ohio River Valley.

Fourth, we are providing critical habitat for rare and endangered species at both of the sites we will be talking about. With that brief summary, I'll defer to our next speaker, Jack Mallory.

## SESSION I: AQUATIC HABITATS

# AQUATIC HABITAT DEVELOPMENT ON THE TOMBIGBEE RIVER, ALABAMA

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## Introduction

Construction of the Tennessee-Tombigbee Waterway (TTW) converted much of the free-flowing Tombigbee River into a series of run-of-the-river reservoirs with deep, slow-moving water and fine-grained substrate. Reservoir construction provided habitat for slack-water species at the expense of organisms that normally inhabit riffles and gravel substrate (McClure 1985). The Tombigbee River was well-known for having a dense and diverse riverine fauna, including darters, minnows, and invertebrates such as snails, oligochaetes, and aquatic insects. Selected reaches with gravel and sand substrate provided habitat for freshwater mussels, many of which were collected for commercial purposes.

Ecosystems altered by construction of dams and channel diversions are now the most prevalent habitats on earth (Standford and Ward 1979). This demand on lotic ecosystems has brought about an interest in habitat improvement and creation to offset losses. Sand and silt from maintenance dredging in navigable waterways have been used many times to develop wetland habitat or nourish beaches. In addition, submersed habitat (shoals and bars) can be created in navigable waterways with gravel or cobble. Gravel has been used to make trout habitats and to accelerate biological recovery in streams modified by channel development. These habitats provide sources of food and cover for aquatic insects and fishes that require coarse particulate matter and rapidly flowing water.

In March 1985, the Mobile CE District constructed two gravel bars in an abandoned channel of the Tombigbee River near Columbus, MS. This project had two objectives: (a) provide habitat for organisms that were more abundant in the river prior to construction of the TTW; and (b) develop guidelines for aquatic habitat rehabilitation or improvement in navigable waterways using dredged material. This paper describes the habitat and how it was built and summarized physiochemical and biological changes during the first 2 years after construction.

## Study Area

The TTW was constructed to provide a more direct shipping route between the eastern gulf coast and the mid-continental United States. This was accomplished by connecting the Tennessee and the Tombigbee Rivers in extreme northeastern Mississippi. The Tombigbee River originates in northeastern Mississippi, flows southward along the eastern border of the state, then enters Alabama near the town of Pickensville. The confluence of the Alabama and the Tombigbee Rivers forms the Mobile River, which enters Mobile Bay, an inlet of the Gulf of Mexico. Average discharge at Columbus, MS, averages 183 cu m/sec. Minimum and maximum values were 3.6 and 5,460 cu m/sec, respectively.

The site chosen for this project was a reach of the original Tombigbee River that was isolated by construction of Columbus Lock and Dam (Figure 1a). The lower end of this river reach joins the TTW, and the upper end terminates at Columbus Dam. A minimum flow release structure removes surface water from Columbus Lake and sends it down a riprapped flume into the upper end of the abandoned channel. Substrate in the upper reach of the abandoned river channel consists of clay with a maximum water depth of about 6 m during normal pool levels. Construction of Columbus Lake, Lock and Dam, and the minimum flow release structure was completed in 1981.

## Methods

Samples of dissolved oxygen, total hardness and alkalinity, major nutrients, and substrate particle size and total organic content were obtained in June and October 1985-1986. Standard techniques were used to analyze all samples (American Public Health Association 1975). Water velocity was measured immediately below the water surface and at the substrate-water interface with a Marsh McBurney current meter.

Fifteen Petite Ponar (232 sq cm) samples for invertebrates were collected in each riffle in June and October 1985, and five samples were obtained in each riffle in June and October 1986. The jaws of the Ponar were forced into the gravel by hand to ensure obtaining a complete sample. Sediment was preserved in 10 percent formalin, returned to the laboratory, and sieved with a 500-μm screen. Organisms were transferred to 70 percent ethanol, stained with rose bengal, then hand-sorted with the aid of a binocular dissecting microscope.

Fishes were collected at and immediately downriver of the gravel bar habitat in October and December 1985 and in May and August 1986 between 1300-1600 hours using a boat-mounted electroshocker. The down- and upstream areas were blocked with 6.3-mm mesh nets, and three separate collections of equal effort were made using the electroshocker. A 5,000-watt generator with a VVP-15 Coffelt electrofisher provided constant direct current at 4-6 amps and 300-400 volts. Stunned fishes were collected with long-handled dip nets, weighed to the nearest gram, and measured in length to the nearest millimeter. Fish density was estimated in December 1985 and May 1986.

## Construction Details

To meet the objectives of this project, it was necessary to increase water velocity, decrease water depth, and provide suitable substrate for riffle inhabiting species. Design of the gravel bar was based upon physical and biological conditions at a site in the Buttahatchie River near Columbus (Figure 1a). The man-made gravel bar was to be similar to the natural habitat with respect to substrate particle size, water depth, and velocity. A description of physical and biological conditions at the natural bar can be found in King et al. (1982) and Miller et al. (1983). Conditions in the Tombigbee River prior to construction of the TTW can be found in Crossman et al. (1975).

It was necessary to constrict the channel of the river to increase water velocity. The first step was to transport dredged material, consisting mainly of sand, to the site by barge. A clamshell dredge was used to fill a 120-m reach of the channel to an elevation of 130 ft msl, which is about 2 m below normal water level. The fill was then capped with 24,000 cu m of 2-80 mm coarse sand and gravel brought in by barge (Figure 1b).

The gravel was placed to create two exposed bars with a riffle or channel down the center of each. Both riffles are 46 m long and 24 m wide, and have a maximum depth of 1.2 m. The dredged material fill constricts the channel cross section and causes a velocity of approximately 45 cm/sec, which is sufficient to remove excess sediment but not to erode the gravel (Vanoni 1975). At high discharge, the entire habitat, including the normally exposed areas, is covered with backwater from the TTW. When flood levels recede, the water is again restricted to the channels, and the velocity returns to 45 cm/sec.

## Results and Discussion

### Physiochemical conditions

With the exception of the occasional influence of backwater from the TTW, chemical conditions at the gravel bar are mainly influenced by Columbus Lake. The water at the site was moderately hard (59 to 156 mg/ℓ calcium carbonate, avg - 98 mg/ℓ, N = 10), alkaline (pH = 7.2 to 8.2, avg. = 7.8, N = 6), with occasional periods of high turbidity (7 to 109 NTU, avg. = 46 NTU, N = 10). Total phosphorus was less than 0.1 mg/ℓ (N = 6), and nitrate nitrogen ranged from <0.01 to 1.7, N = 7. Percent oxygen saturation ranged from 92 to 100 percent (avg. = 96, N = 11). Water temperature, which was affected by lack of canopy cover and solar radiation on the impounded waters immediately upriver, ranged from 4° C to 32° C annually.

### Macroinvertebrates

Macroinvertebrate colonization at the new habitat was rapid. Four months after construction (June 1985), 19 and 21 taxa were found in the first and second riffles, respectively (Figure 2a). The samples collected in June 1986 contained 24 and 25 taxa, which was not substantially different from the

previous year. Macroinvertebrate species richness was greater in the fall than in the spring. This seasonal variation, noted also for total density and biomass, was the result of macroinvertebrate-like history strategies. In the spring, most adults had emerged, and the resulting eggs had either not hatched or the immature forms were not identifiable. Similar patterns have been found in other research.

Total macroinvertebrate density exhibited the same trends as species richness (Figure 2b). Significant density differences ($p<0.01$, Student's T-test) existed between June and October of each year although there were no significant density differences between years for each season. These data indicate that the riffles had been colonized by the majority of the invertebrates within the first few months after construction. Values for total invertebrate biomass were similar in June of each year (Figure 2c). However, total biomass in October 1986 was significantly greater than in October 1985.

In June 1985, the majority of the macroinvertebrate assemblage consisted of immature flies in the family Chironomidae (Figure 3a). Throughout the study period, the density of chironomids remained approximately the same; however, their percent composition declined in comparison to other taxa such as aquatic worms and bivalves (mainly *Corbicula fluminea*). The increase in biomass during the study period was due to colonization and subsequent growth of bivalves (Figure 3b). By October 1986, density of bivalves had increased, and because of their larger size, were the dominant component of the biomass.

Most aquatic insects colonize new substrate by downstream drift or dispersal by adults that fly (Fisher 1983, Light and Adler 1983, Minshall and Peterson 1985). At this gravel bar, these two mechanisms probably account for the majority of the aquatic insects in the riffles and pool. However, upstream movement in the water and along the bottom does occur (Bishop and Hynes 1969), especially by taxa which are solely aquatic throughout their life cycle (Light and Adler 1983). The Asiatic clam *Corbicula fluminea* can disperse by entering the drift and being carried on currents by a mucus thread (Prezant and Chalermwat 1984). Macroinvertebrates from Columbus Lake and the riprapped flume below the release structure are close enough to easily colonize this site.

## Fishes

Forty-two species of fishes were collected in the four-season study; 39 were found over the gravel bar, and 25 were found in the river channel immediately below the habitat. The crystal darter (*Ammocrypta asprella*), listed as endangered by the State of Mississippi, and the blue sucker (*Cycleptus elongatus*), considered to be uncommon in the Tombigbee River, were collected. Dominant species at the habitat, which included the pool and riffles, included gizzard shad (*Doromosa cepedianum*), threadfin shad (*D. petenense*), blue gill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), bullhead minnow (*Pimephales vigilax*), white crappie (*Pomixis annularis*), and orange-spotted sunfish (*Lepomis humilis*) (Figure 4).

Total fish density at the gravel bar was 1,150 fish/ha in December 1985, and 2,893 fish/ha in May 1986. These densities are lower than expected

(3,256-16,720 fish/ha) in natural streams with riffles (Schlosser 1985, Kelly et al. 1981). However, the habitat at Columbus exhibited similar species composition as smaller streams with pool-riffle sequence.

The fish community was characterized by relatively high percentages of minnows and shiners (Figure 5), indicative of lotic conditions. In December 1985 and August 1986, there were comparatively few minnows and shiners in the deep, slow-moving channel immediately below the habitat. Pennington et al. (1981) studies bendways in the Tombigbee River in 1979-1980 when the TTW was under construction. In Hairston Bend, which had not yet been isolated from the TTW, they found relatively high numbers of minnows and shiners (Figure 5). Big Creek Bendway, which had been cut off from the main river at the time of their survey, exhibited lentic conditions with few minnows and shiners and large numbers of shad. Based on these data, it appears that the Columbus gravel bar has provided habitat for riverine species that were once abundant in the unaltered river, as well as sport and commercial species.

## Conclusions and Recommendations

These man-made gravel bars are not typical habitats. They are located in an abandoned channel immediately below a dam and protected from high floodwater velocities. A minimum release structure provides a continuous flow of water, and a gravel constriction maintains velocity at 45 cm/sec during normal and low flow. These gravel bars were constructed to create riffle habitats similar to that which existed before TTW construction.

Biologists in resource development agencies, as well as management and conservation organizations, frequently search for productive uses of dredged material. Gravel and sand from construction and maintenance dredging can be used for a variety of commercial and recreational purposes, including creation of submerged habitats in navigable waterways. The following recommendations, based upon experience gained from this project, concern beneficial uses of dredged material.

a. Although fine-grained material is not as suitable as gravel for many benthic invertebrates, fine-grained sediments can be used to construct aquatic habitats. Fine sediments can be used as fill and then capped with gravel.

b. Sand and silt can provide habitat for a dense community (usually with low species richness) of immature flies and aquatic worms. However, larger-sized particles are typically inhabited by a greater variety of species. Consideration should be given to enriching fine-grained sediments with large particles. Riprap, cobble, or any large diameter rock could be used, even if spread at very low densities (i.e., one rock per 5-10 sq m).

c. At Columbus, the majority of the biota reached the site within several months. Manmade aquatic habitats can provide a source of invertebrate food for fish and other higher organisms soon after construction.

d. Water velocity of 45 cm/sec will erode fine sand and silt, which can settle during periods of low flow. Hynes (1970) lists water velocities

required to move various sized inorganic particles and should be consulted to determine if water velocity will erode recently placed dredged material.


## Acknowledgments

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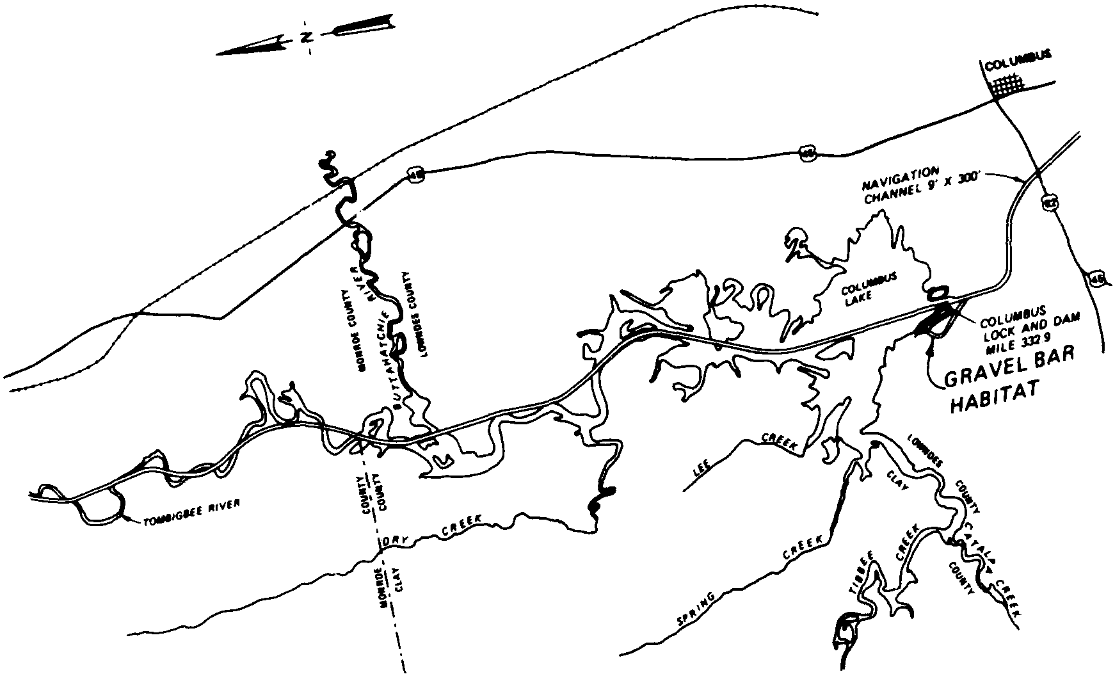



Figure 1a. The Tombigbee River and the abandoned channel where the gravel bar habitat is located

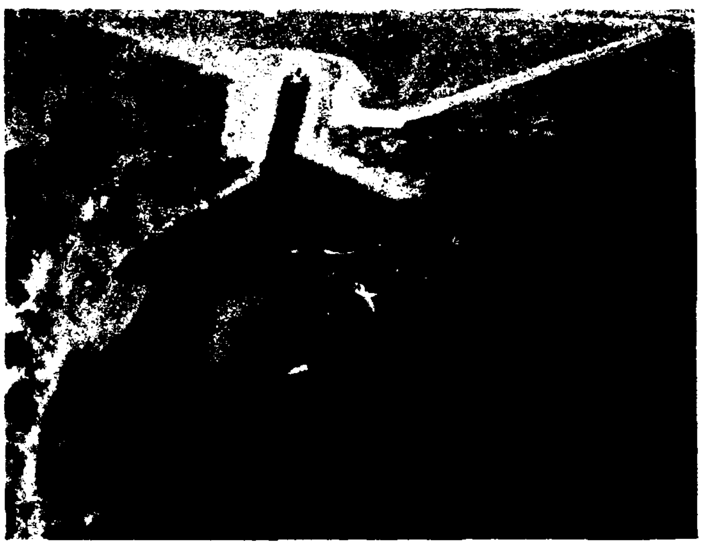


Figure 1b. An aerial view of the completed habitat

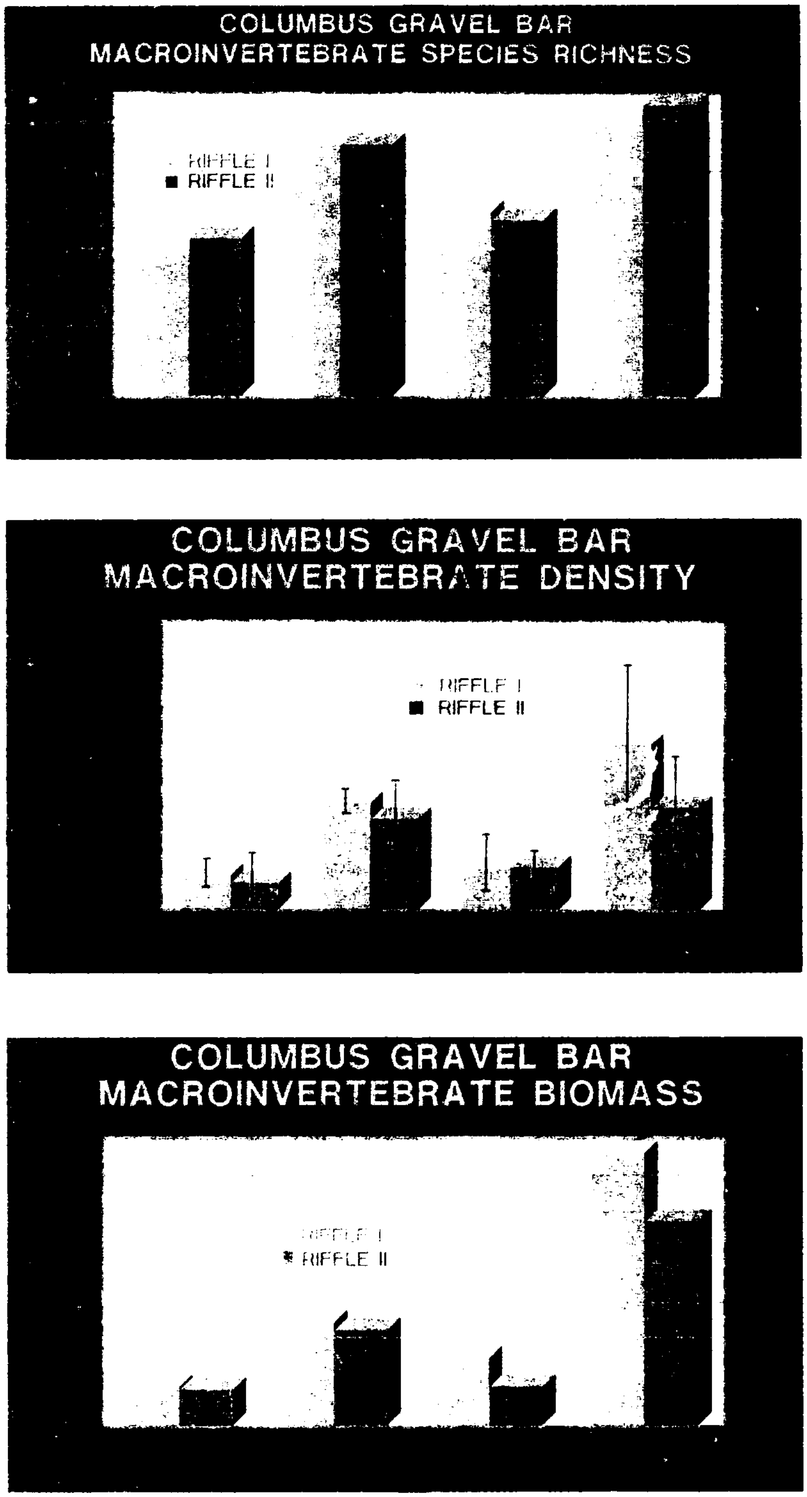
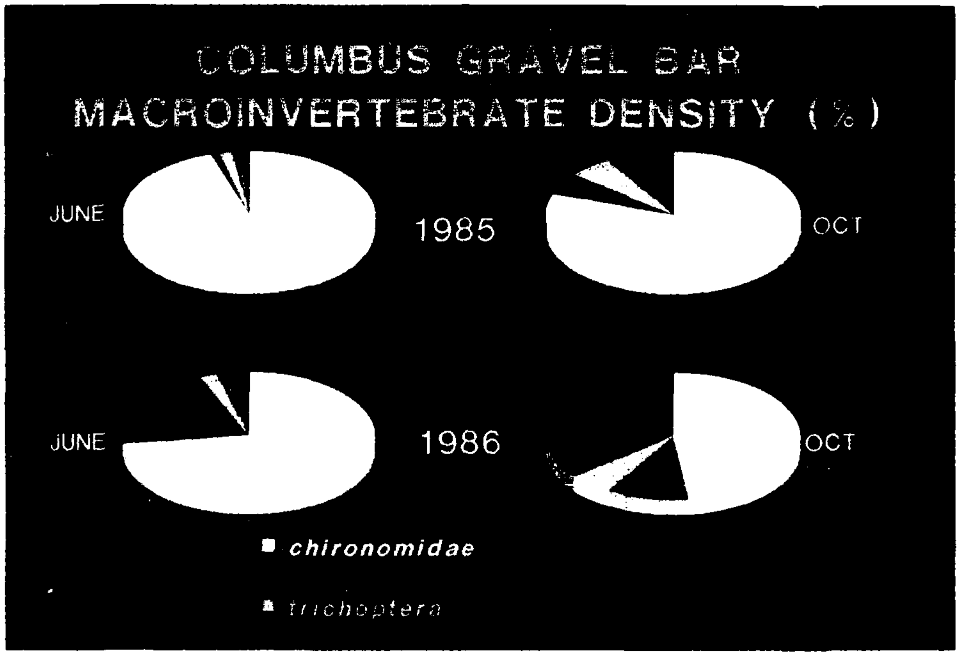



Figure 2. Data collected at the gravel bar habitat in 1985 and 1986: (a) macroinvertebrate species richness, (b) total density, (c) total biomass



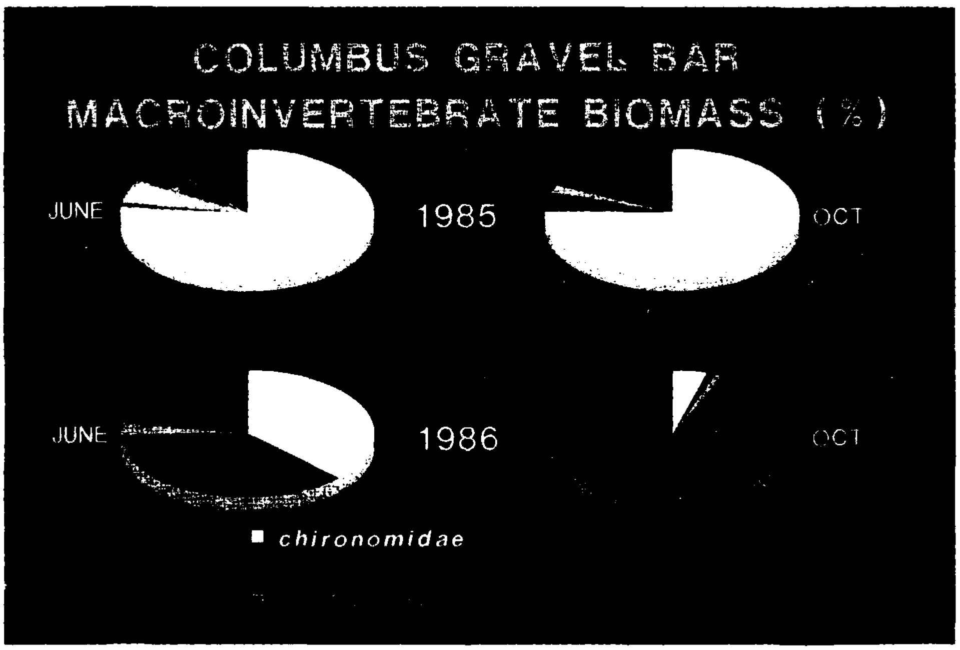




Figure 3. Data collected at the gravel bar habitat in 1985 and 1986: (a) percent macroinvertebrate density, (b) biomass

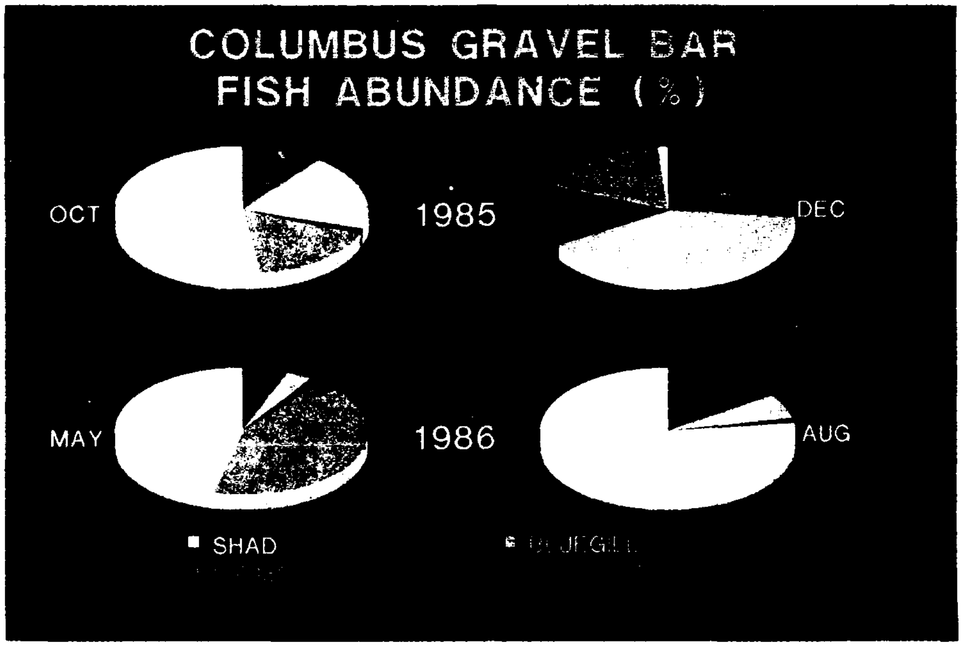



Figure 4. Percent abundance of fishes based upon catch/unit effort at the Columbus gravel bar habitat in 1985 and 1986

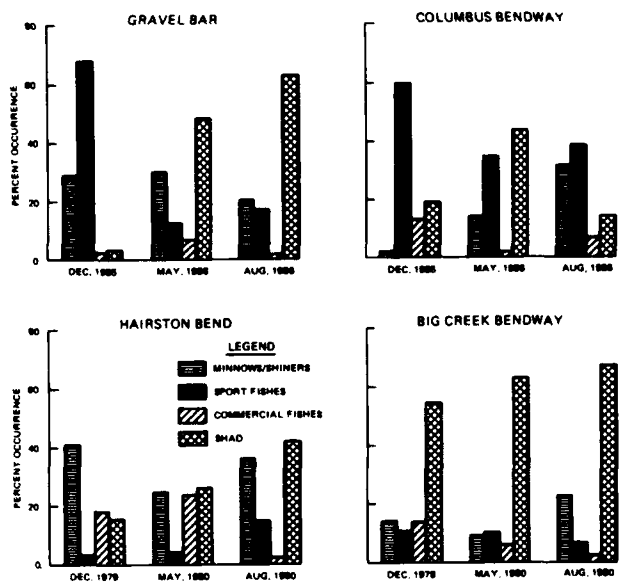



Figure 5. A comparison of fishes collected at the gravel bar habitat and the bendway downstream of the habitat in 1985 and 1986, at the unaltered Hairston Bend, and the altered Big Creek Bendway. Latter data from Pennington et al. (1981)

QUESTION: I noticed a couple of heelsplitters in your sample slide. Could you explain how those got there, and how they got so big so quickly? Have you thought about seeding other species in there to try to get them started?

DR. KING: The heelsplitters did not come from that river. The slide was from another river Dr. Miller worked in, and we just used it to illustrate potential. Yes, we have thought about introducing other species to the gravel bar. We were hesitant at the beginning of the study because we wanted to see what the site would do on its own. We have 2+ years data now, and we still haven't decided about species introduction!

There are five species occurring in the Tombigbee River that are all listed as endangered or rare. One is relatively abundant in the Buttahatchie River, a tributary of the Tombigbee, and we talked to the FWS Endangered Species Office about moving some of the species to the gravel bar. However, one of the problems we faced was that these species use a fish at an intermediary stage in its life cycle, and we don't know which species of fish is used by these rare bivalves. Therefore, if we move them, the fish may not be present, and the species won't survive although with the large numbers of fish species showing up on the bar, I think the probability of the correct species being there is good and worth the risk.

I am particularly encouraged that darters and other fishes that normally dwell on gravel bottoms are living at the gravel bar rather than just species that happened to be at or near the bar when sampling occurred.

QUESTION: How many of these rare species have come in on their own?

DR. MILLER: Two.

QUESTION: I am curious to know what percentage of the river was this type of habitat before you built the TTW?

MR. MALLORY: I don't know, but historically, there were probably 10-12 areas in the river with enough gravel where these species occurred. These were shoal areas and were frequently associated with railroads where rock and gravel were used for trestle material, which found its way into the river. We did not intend to mitigate the habitat lost with this project. This was a demonstration, but it does mitigate a little bit. At this point, I am encouraged that we can build aquatic habitat similar to that lost and that it works.

QUESTION: You are dealing with a controlled flood environment in the Tombigbee River. How does this project relate to one in a natural river where flows cannot be controlled?

DR. KING: It is not going to in that sense---we had already thought about that. However, there are other locations where we could test a natural river flow situation using dredged material, and there are controlled rivers where our current demonstration is applicable. In the Tombigbee at the Aberdeen Lock and Dam and in the canal section of the TTW are two excellent potential test locations. Remember, the river does flood this gravel bar several feet deep. If we put this type of habitat out in the middle of the rivers, it

would be in the way of navigation and channel maintenance. It has to be in a side channel or other out-of-the-way spot.

SESSION I: AQUATIC HABITATS

# AQUATIC HABITAT CREATION ON THE OHIO RIVER, WITH REGULATORY CONSIDERATIONS

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## Introduction

Gravel bars are notable natural features of rivers and streams that have not been altered by water resource development. Gravel and cobble-sized materials provide points of attachment and anchorage for immature insects, snails, and worms (Hynes 1970). Coarse-grained particulates stabilize fine substrate and allow colonization by long-lived invertebrates, such as freshwater mussels. Particle size distribution, degree of embeddedness, and presence of attached organic matter and plants determine the characteristics of invertebrate communities in lotic systems (Cummins and Lauff 1968, Brusven and Prather 1974, Walton 1978).

Selected reaches of navigable waterways frequently have to be dredged to provide access to ports and loading facilities. Environmental legislation such as the WRDA and the Endangered Species Act of 1978 have encouraged beneficial uses of dredged silts and sands to create upland terrestrial or wetland habitats. However, gravel or other large-sized particles can be placed in rivers to create shoals or bars. Gravel has been used to make trout habitat (Stuart 1953), to accelerate biological recovery in streams modified by channel development, and to increase water velocity and provide substrate for invertebrates (King and Miller 1986).

Habitat creation techniques in navigable waterways are simple, operationally feasible, and should be considered when appropriate material and a suitable site are available. These habitats can be built with sediment from maintenance dredging, which often reduces material transport costs. When incorporated into early planning, habitat development can satisfy environmental concerns and meet project purposes.

### Background

In December 1980, a grain company on the Lower Ohio River near Mound City, IL, applied to the Louisville CE District for a permit to dredge an access to their barge loading facility. As part of the permit evaluation, the

FWS and the Illinois Department of Conservation (IDC) recommended that a mussel survey be conducted at the site. At the river reach, there is a diverse mussel community that includes the orange-footed pimpleback (*Plethobasus cooperianus*) (Williams 1969, Miller et al. 1986), which is listed as endangered by the FWS.

During a period of extreme low water in the fall of 1983, the grain company dredged an access to their loading facility although no permit had been granted. This killed an unknown number of common (but not endangered) mussels. As a result, the grain company was in violation of Sections 10 and 301 of the Clean Water Act. Personnel from the District, FWS, and IDC proposed and evaluated a series of measures to offset the damage to the mussel bed. Some of these suggested compensatory measures included construction of a boat ramp, providing funds to conduct mussel research in the Ohio River, eliminating or reducing sedimentation on the existing mussel bed, and constructing an experimental gravel bar for mussels.

In November 1984, the grain company agreed to the agencies' decision that they should construct an experimental gravel bar. The rationale for the decision was (a) that the grain company should be made to compensate for damage, and (b) that mussels are a valuable resource in large rivers and their habitat should be protected or created whenever possible. In addition, this project provided an opportunity to investigate techniques for constructing and monitoring artificially placed habitats. The gravel bar had to be located at a suitable site outside the navigation channel where there were no live mussels. A design for the habitat was prepared by personnel of WES, and in August 1986, gravel was placed in the river. This paper describes techniques for site selection and habitat construction.

### Value of Freshwater Mussels

Freshwater mussels are usually found in gravel shoals or bars in large rivers. Because they are long-lived (20 or more years for some species) and feed by filtering organic matter out of the water, their presence reflects past habitat conditions (Fuller 1974). Mussel shells were once used to make pearl buttons; however, shells of certain species are now shipped to the Orient and made into inserts for the cultured pearl industry (Sweaney and Latendresse 1982, Sitwell 1985). There are over 200 species of mussels in the US. Thirty of them are listed as Federally endangered.

## Site Selection

On the Kentucky side of the Ohio River across from Mound City (RM 971.3-973.3) is an exposed shoal built from past maintenance dredging operations (Figure 1). At low flow, water behind the shoal ranges from 3 to 4 m deep, which is suitable for mussels and other benthic organisms. The main component of the benthic fauna, based upon collections made in 1984, was the Asiatic clam (*Corbicula fluminea*), a nonnative clam. The population density ranged from 0 to 646/sq m, with an average density of 224 sq m (sd = 232.6, N = 9). Intensive searches using a brail (a bar with 200 or more multipronged hooks that is dragged over the river bottom) and scuba divers yielded only three

native mussels: one ebonyshell (*Fusconaia ebena*), and two pink heelsplitters (*Potamilus alatus*). Although optimal mussel habitats usually consist of sand and gravel (Figure 2a), this shoal consisted of coarse sand with less than 10 percent gravel (Figure 2b).

A site with suitable depth and water velocity was selected at RM 972.0 (Figure 1). Water velocity at the bottom ranged from 20 to 33 cm/sec during low flow, which is sufficient to keep the substrate free of fine sediments (Vanoni 1975). Presence of Asiatic clams and a few larger mussels indicated that high current velocities do not disrupt the substrate. The site was outside the navigation channel and protected from commercial traffic.

It was determined that the gravel bar should measure 150 m long by 30 m wide. A structure this size is large enough to be found easily by divers and provides sufficient habitat for mussels and other macroinvertebrates. Enough material was obtained to construct a gravel bar that would be at least 25 cm deep. Most aquatic insects are in the top 5 cm of substrate, and freshwater mussels are usually in the upper 15 cm of a gravel bar.

## Site Construction

A hydraulic dredge with a 27.5-cm-diameter intake pipe and suction created by a 335 hp engine was used to pump gravel from the main channel. Material was sieved through a 9.5-mm-diameter screen, and only the coarse sediments greater than 9.5 mm were retained. Since sand was the primary sediment type at the site, only coarse material would be used for the new habitat. It took about 8 hr to pump and load 3,200 cu m of gravel.

The site was delineated by buoys that were set at 46-m intervals along the landward side of the habitat. A tug was used to keep the crane barge and materials barge in position throughout the operation. This was done because it was difficult to keep the barges in position with spuds (heavy metal poles normally used to secure barges). The crane operator used a 24-m boom and a 3-cu-m clamshell bucket. About two-thirds of a load of gravel was spread in the river along the right and front sides of the barge. The gravel was placed as evenly as possible by opening the bucket slowly as the boom moved above the water surface. After most of the gravel was placed along the front and right side of the barge, the tug moved the equipment approximately 15 m to the left. The remaining gravel was then placed where the barge was positioned when the first two-thirds of the gravel was spread (Figure 3).

Each 46-m section of the bar required one bargeload of gravel (about 800 cu m). Work proceeded downriver so that propeller wash from the tug would not disturb the newly placed gravel. It took from 4 to 6 hr to position the tug and equipment and unload a single barge. Four bargeloads of gravel were used (about 3,200 cu m).

After all gravel had been spread, divers measured the dimensions of the bar, secured a reference cable (Figure 4), and collected substrate samples with a hand-held corer. The gravel layer was 3 to 75 cm deep and the majority of the gravel was within the area marked by the buoys. The upper 15 cm of

substrate contained approximately the same size distribution of particles (Figure 5). An even vertical distribution of particles was achieved by having the crane operator open the clamshell bucket slowly and spread the material in layers. It was not necessary to smooth the gravel after it had been placed.

## Continuing Studies

Approximately 100 ebonyshell mussels (*Fusconaia ebena*) were collected from the Illinois side of the river and transported to the site. All specimens were marked, total length measured, and hand placed in the substrate. The marked mussels will be sampled at intervals for determination of individual mortality and growth rate.

Physical and biological conditions at the habitat will be studied for the next 4 years. Samples will be collected to analyze particle size distribution and composition of the invertebrate community. Divers will be used to determine if mussels are recolonizing the habitat naturally.

## Acknowledgments

Personnel from Consolidated Grain and Barge Company, Mound City, IL; Delta Material Inc., Shawneetown, IL; and the Waterfront Services Company, Cairo, IL, assisted with this project. Funds for construction and initial investigation of the habitat were provided by Consolidated Grain and Barge Company. Tennessee Valley Authority divers Messrs. Larry Neill, William Host, Jr., and Jim Walden participated in the data collection.

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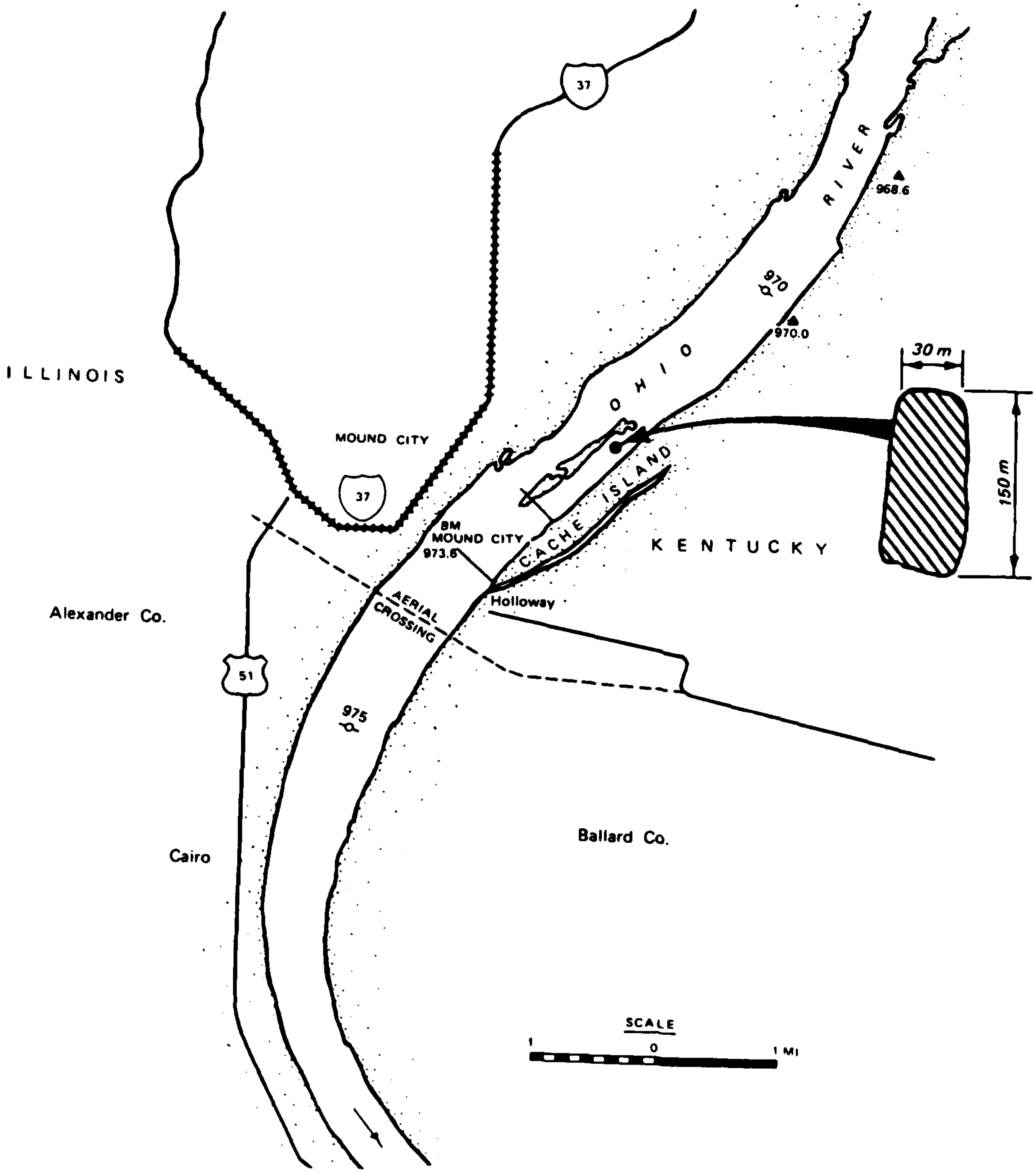


Figure 1. The gravel bar was placed behind a shoal on the Kentucky side of the Ohio River near Mound City, IL

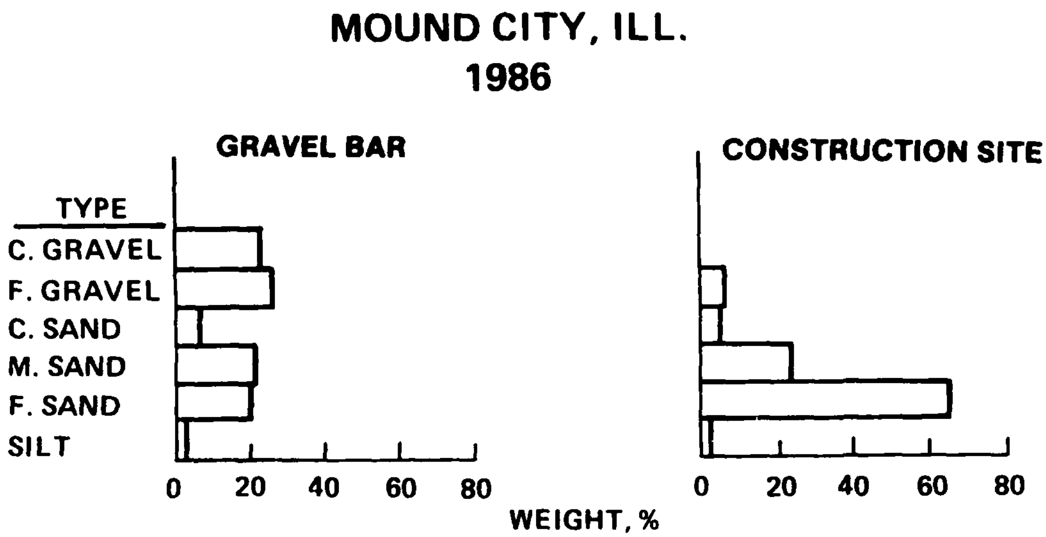


Figure 2. Particle size distribution of inorganic sediments from a natural gravel bar that supports mussels and the construction site

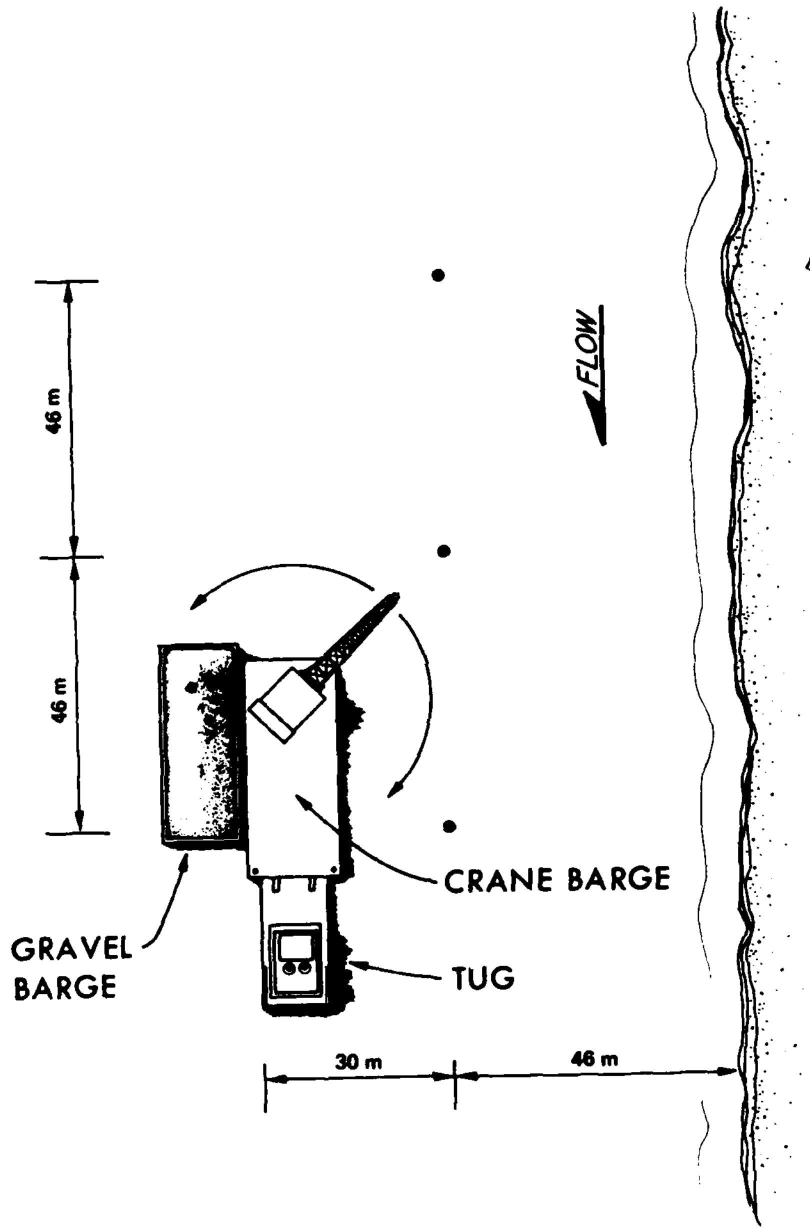


Figure 3. Construction of the gravel bar habitat in the Ohio River

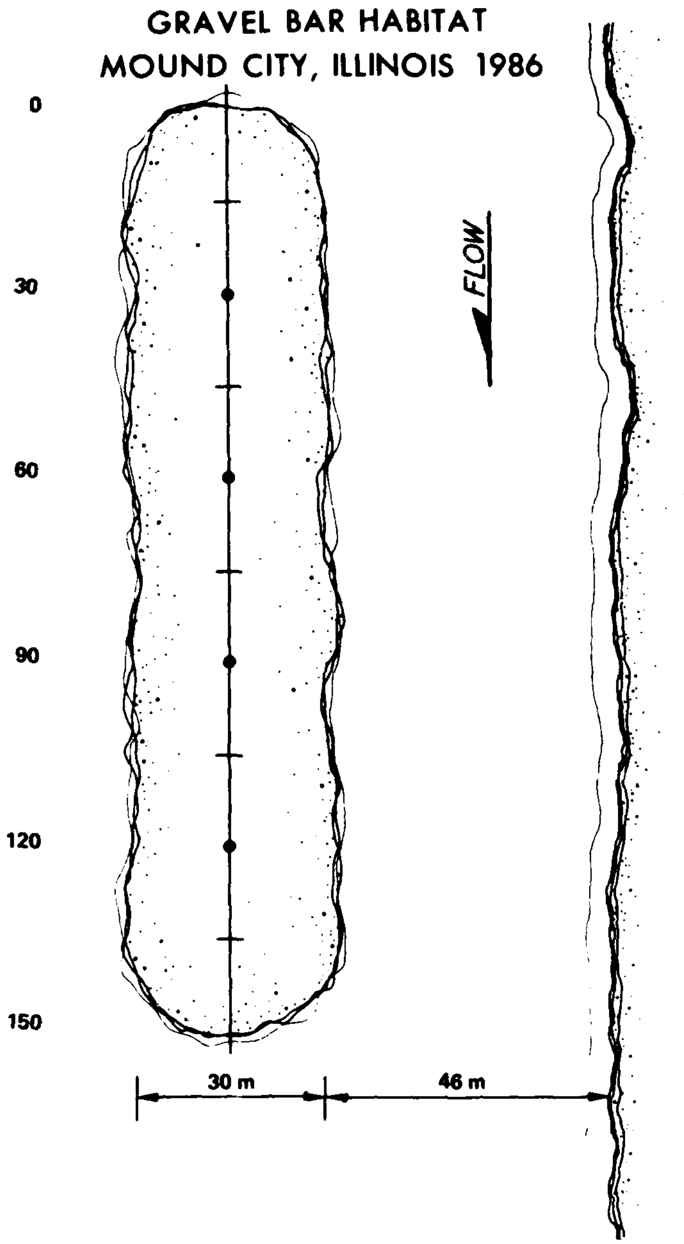


Figure 4. Diagram of the completed gravel bar habitat in the Ohio River

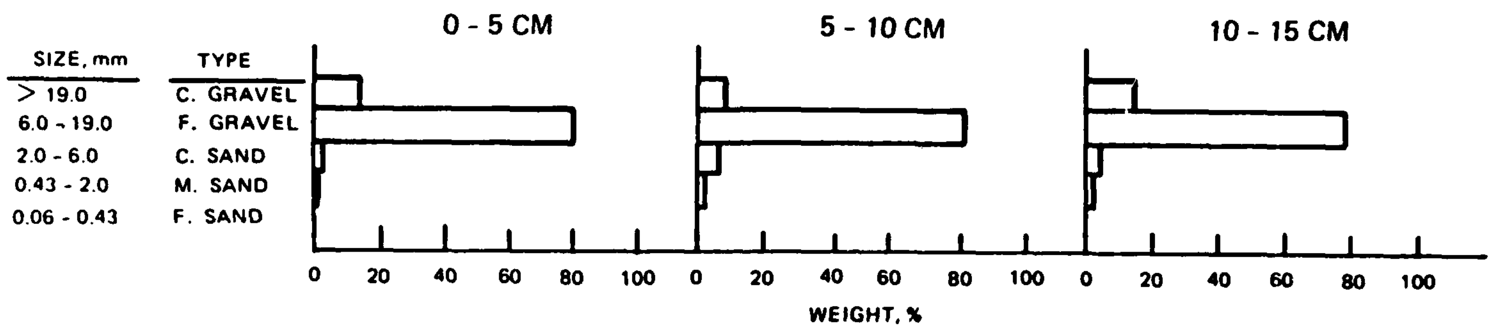


Figure 5. Vertical distribution of inorganic particles at the newly completed gravel bar in September 1986

SESSION I: AQUATIC HABITATS

# RESULTS OF SALMONID FISH HABITAT RESTORATION WITH DREDGED MATERIAL IN THE CAMPBELL RIVER ESTUARY, BRITISH COLUMBIA, CANADA

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## Introduction

In January-February 1982, four intertidal islands for the rehabilitation of salmonid habitat were constructed at the Campbell River estuary in British Columbia using gravel and sand dredged to build a new dryland sort. BC Forest Products, the Department of Fisheries and Oceans, and the Canadian Wildlife Service collaborated to build the islands which were part of a plan to recover a major portion of the estuary from log storage. About 26.0 ha of log storage area were given up and within this area 3.3 ha of intertidal islands were constructed. Cores of vascular plants from a donor site were planted on the islands, and provision was made to study colonization by plants and use of the habitats by invertebrates and juvenile salmon. This paper describes the basic elements of the project and the preliminary results of the research and monitoring program which began in November 1981.

## Construction and Planting

Complete details of the construction and planting program are described in Brownlee et al. (1984), but a summary is presented below. All construction activity was conducted during fall or winter to avoid impact on adult or juvenile salmonids which are generally not present in estuaries at these times (Levings 1982).

Primarily gravel dredged material was pumped by cutter suction dredge from the new log sort bay area in January 1982. Approximately 30,000 cu m of gravel were subsequently moved by trucks, power shovels, and front end loaders to create two peninsulas extending out into the estuary. The peninsulas were eventually breached by bulldozer in February 1982 to create three separate islands plus a fourth connected to the original estuary shoreline. The islands were graded to match elevations suitable for estuarine vascular plants, and a layer of fine material (mostly sand and silt) was mixed with the surficial gravel. Bulldozers were used to create coves and tidal channels at lower elevations at each of the islands.

In November 1981, approximately 700 sq m of donor plant material was moved in 1- by 2-m by 12-cm mats weighing about 1 ton each. This material was stored in an undisrupted part of the estuary until February 1982 when the mats were cut into plugs, each about 12 by 12 by 12 cm. About 22,850 plugs were

planted during 1-5 February 1982, in an experimental design which made allowance for unvegetated space between planted areas.

## Vegetation

Annual monitoring for survival, development, and productivity of the transplanted vegetation has been conducted by the Canadian Wildlife Service. Few published reports are available; however, Dawe (1984) reported that by July 1982, 29 species of vascular plants were found on the islands. Of these, the dominant species in terms of frequency were *Carex lyngbyei* (76 percent), *Eleocharis palustris* (55 percent), *Potentilla pacifica* (42 percent), and *Juncus balticus* (39 percent). In mid-August 1982, the proportion of successful plugs over the whole estuary was 92.5 percent. By 1985, the unvegetated plots were indistinguishable from planted areas, and growth rates of vegetation were estimated to be 60 percent of natural communities on Nunns Island, the reference area used in the study (Dawe 1986). Data from 1986 indicated average plant biomass on three of the man-made islands was approximately 272-g dry weight/sq m, about 31 percent of the biomass of a lower elevation site on Nunns Island, but about 180 percent of mid-elevation communities (Dawe 1987, personal communication).

Macrobenthic and microbenthic algae were not investigated thoroughly in the monitoring program. However, visual observations during the vegetation work showed extensive coverage by filamentous green algae (especially *Enteromorpha* spp. and *Spongimorpha* spp.), and at lower elevations by a major colonizer, the rockweed *Fucus distichus*. For example, by summer 1986, 100 percent of the northern end of Island 3 was colonized by rockweed. No planted vegetation survived here probably because of the higher salinities in the lower elevation at this part of Island 3.

## Invertebrates

Invertebrates were sampled using quadrats (Riley et al. 1987) and epibenthic sleds (Kask et al. 1986) at low tide. Sled sampling targeted meiobenthic crustaceans such as harpacticoid copepods, which colonized the island habitats rapidly. By summer 1982, densities of meiobenthos on the islands were very similar to those from adjacent reference habitats which had an estimated 1,000 organisms/sq m (Kask et al. 1986). This pattern was also observed in 1983.

Macrobenthic animals colonized tidal channels and coves within a few months of island construction. A few days after the channels in Island 3 were constructed, we observed mobile epibenthos, particularly gammarid amphipods (*Eogammarus* spp.) and mysids (*Neomysis mercedis*), moving into island channels on rising tides. By July 1982, density of macrobenthos in coves and channels were similar to reference habitats (Riley et al. 1987). Another survey in May 1983 showed a similar pattern (Anderson and Galbraith 1985). Abundance of

crustaceans on Island 3 was highest with mean maximum abundance of approximately 26,600/sq m for *Corophium spinicorne* compared to 3,770/sq m on coves on Island 1.

Macrobenthos on the tops of the islands at higher elevations where the vegetation was planted appeared to invade the new habitats more slowly. Insect larvae were a notable exception. Insect larvae densities were very similar to the reference areas on Nunns Island by the end of summer 1982. The sabellid polychaete *Manayunkia aestuarina* also colonized the new islands quickly. Other species, in particular crustaceans such as the amphipod *Corophium spinicorne*, showed a variable rate of increase. Density of macrobenthos on Nunns Island decreased over the monitoring period, so the merging of densities on reference and manmade islands was due to this effect as well. The decrease in densities on the reference island may be attributed to a shift in local climate or long-term cycling of populations. An alternate explanation is the possible removal of macroalgae cover, especially *Fucus* and *Pelvetiopsis* spp. and fine sediments on Nunns Island although this is based on qualitative observations.

## Fishes

Over the 5 years of sampling, juvenile chum (*Oncorhynchus keta*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshtwyscha*) were obtained by beach seine at the manmade islands. A hatchery is located about 8 km upstream in the estuary, and both wild and hatchery-reared salmonids were taken from the estuary work (Levings et al. 1986). Chinook and chum were the most consistent island users.

Comparisons of catches of wild chinook and chum were made with island stations and several reference sites on the estuary which showed consistently high catches. These stations were not on Nunns Island. Annual mean catches of wild chinook at one of these reference sites were stable with about 100 fish/100 sq m. Wild chinook were most abundant on Island 3 where catches were approximately 190 fish/100 sq m in 1982, declining to less than 20 fish/100 sq m in 1984, and increasing to a maximum of approximately 480 fish/100 sq m in 1986. Using the same reference site over the five field seasons, wild chinook catches were not significantly different ($p > 0.01$) on Island 3, but were significantly lower at Islands 1 and 4 ($p < 0.01$).

Island 3 was also heavily utilized by chum fry, and the highest annual mean catch was 70 fish/100 sq m. Compared to a reference station, chum catches were significantly higher ($p < 0.01$) at Island 3 when data from all years were combined. Catches on Islands 1 and 4 were significantly lower ($p < 0.01$).

Analyses of stomach contents of juvenile chinook taken at the islands showed that fish caught at these stations were feeding on a variety of pelagic and epibenthic invertebrates. Harpacticoids and amphipods were likely produced on the islands, but insect larvae and adults could have been produced further upriver. Chinook caught at Island 3 also feed on calanoid copepods brought into the estuary via the salt wedge (Brown et al. 1987). In feeding

experiments conducted in May 1983, fish were held in pens over planted vegetation on one island and an adjacent natural marsh. Results showed the fish fed on organisms produced on the island. This is good evidence that food potentially available to juvenile chinook was being produced on the islands.

## Conclusions and Summary

Results to date indicate the restoration work at the Campbell River estuary has been successful, but considerable variation exists between habitats when results are examined in detail. Future work at the area will emphasize long-term monitoring, and we hope to use the Campbell River estuary as an area to calibrate other estuarine restoration and compensation sites, particularly in the lower Fraser River and estuary.

The vascular plant community at the Campbell River estuary appears to be functioning quite well (Dawe 1987, personal communication) although further detailed comparisons are required with earlier estimates in 1976 (Kennedy 1982). The establishment and abundance of invertebrates since 1982 has also been variable with crustaceans, polychaetes, and insects dominating. The latter taxa appeared to be the earliest colonizer. The abundance of the total invertebrate community in 1986 was comparable to a reference site. Juvenile salmonids used the island habitats and were as abundant at certain island sites as at key reference stations. Feeding experiments showed the fishes could feed on invertebrates produced on the islands.

Island construction as a habitat restoration technique in estuaries should be reserved for areas where natural accretion is reduced, as was the case at Campbell River where a dam about 6 km upstream from the mouth has stopped gravel input since 1947. It is important to maintain or increase water volumes in estuaries as a strategy to provide proper fish habitat, but where possible, intertidal production could be augmented by construction of islands. Obviously, physical factors have to be considered when planning such structures and in the case of the Campbell River estuary, minimal wave and current energy and relatively low and constant salinity (Levings et al. 1986) are factors enhancing the probability of the long-term success of the project.

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## SESSION I: AQUATIC HABITATS

# DREDGED MATERIAL PLACEMENT IN THE LITTORAL ZONE AT LAKE OF THE WOODS, NORTHWESTERN MINNESOTA

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## Introduction

Placement of hydraulically dredged material in the littoral zone of Lake of the Woods at Warroad Harbor, MN, was historically conducted by sidecasting material along the entrance channel. In 1983, dredged material from the channel entrance was deposited to form an island near the harbor mouth as a demonstration of habitat development in a large freshwater lake using dredged material.

The Warroad River enters Lake of the Woods at the city of Warroad (Figure 1). A project to provide an inland harbor and access to Lake of the Woods was authorized in 1899. The project consists of a dredged inland harbor, a jetty, and a mile-long access channel to deep water in the lake. Authorized depth of the channel is 2.4 m below the low water datum of 321.9 m NGVD. Average annual accumulation of sediment in the access channel has been about 10,700 cu m, with maintenance dredging required about every 7 years.

Channel soundings conducted in 1981 indicated a need for maintenance dredging. There was some opposition to sidecasting dredged material along the entrance channel, and upland sites were not available. The St. Paul CE District, with coordination with state and other Federal agencies, used the material to build a combination island/wetland habitat.

## Coastal Processes and Habitat Conditions

Lake of the Woods is a remnant of the once extensive glacial Lake Agassiz. Lying on the border between Minnesota and the Canadian provinces of Manitoba and Ontario, the lake covers 3,846 sq km. The Minnesota portion of the lake has simple morphometry, a mean depth of 5.4 m, and an extensive littoral zone. Water levels are regulated to between 323.5 and 321.9 m NGVD by international treaty. The southern portion of the lake is eutrophic and supports a popular year-round sport fishery for walleye and northern pike.

The southern shore of the lake has been shaped by littoral sediment drift. Maximum wind fetch distance is 48 km to the northeast. The beach profile is shallow with the 3-m contour lying approximately 1,600 m offshore. The shoreline near Warroad has remained stable during historic times. An offshore sandbar exists approximately 900 m from the shore. The net littoral drift of sediment due to wave action along the coast of the lake is to the

southeast. Sediment transport is estimated to be about 50 percent greater in a southeasterly direction than in a northeasterly direction or about 17,127 and 11,700 cu m, respectively (Hickock and Associates 1977).

The southern shore and lake bed sediment range from silt and clay offshore to sand in the beach zone. Submerged aquatic vegetation (*Potamogeton* spp., *Myriophyllum exalbescens*, and *Vallisneria americana*) occurs near shore, becoming more sparse lakeward. Bulrush (*Scirpus validus*) occurs in stands as far as a half mile out into the lake. Dense stands of cattail (*Typha* spp.) and reed canary grass (*Phalaris arundinacea*) occur along the shore.

Benthic macroinvertebrates in the littoral zone are most abundant in finer sediments and in areas with submerged aquatic plants. Densities in 1981 ranged from 39 individuals/sq m on sandy substrates to 1,846 individuals/sq m in areas with aquatic plants. The amphipods *Hyallela azteca*, *Pontoporeia affinis*, chironomid larvae, several species of snails, and fingernail clams were the most numerous macroinvertebrates in the vicinity of the dredged material placement site.

## Dredged Material Placement

Surficial material from the approach channel was sampled and subjected to physical, chemical, and bioassay analyses. The material was fine sand with up to 80 percent silt plus clay at some stations along the dredge cut. Bulk and elutriate chemistry indicated that the material was relatively uncontaminated. Concentrations of ammonia, chromium, lead, zinc, mercury, copper, nickel, and cadmium in unfiltered elutriates exceeded EPA chronic toxicity criteria for the protection of aquatic life. Unfiltered elutriate concentrations were sufficiently low, however, to indicate that dredged slurry concentrations of these contaminants would be diluted to below criteria levels immediately upon discharge of material. Solid and suspended particulate bioassays using channel sediments and indigenous test organisms indicated no discernible toxicity to the organisms exposed (Marking et al. 1980).

The placement site was originally proposed to be immediately landward of the offshore bar southeast of the approach channel. However, the Minnesota Department of Natural Resources insisted on material being placed inside the littoral drift zone near the harbor mouth.

The dredging began on 14 June 1983 and was completed in one month. Dredging was conducted with a 30.5 cm (discharge pipe diameter) hydraulic dredge. A baffle was used to dissipate energy at the end of the discharge pipe. The fine texture of the dredged material and wave energy at the disposal site prevented rapid stacking of the material. A circular, 122-m-diameter island was formed with a top elevation of 292.0 m msl, or 1.5 m above low water elevation of the lake at that time (Figure 2). Lake level at the time of dredging was about 293.3 m NGVD.

Color infra-red aerial photographs taken during the dredging operation clearly illustrated the extent of the suspended solids plume. The shape and extent of the suspended solids plume varied considerably between photography

dates although the pumping rate of the dredge remained nearly constant. The plume emanating from the discharge pipe was shaped by slow-moving currents from the pipe discharge, the river current, and wind-driven lake currents (Figure 3). The areal extent of the visible discharge plume varied between 16 and 49 ha during the dredging operation.

Suspended solids concentration of the slurry averaged 219,000 mg/ℓ. Background suspended solids in the lake water were between 1 and 16 mg/ℓ. Suspended solids in the water column near the island during dredging fell to below 300 mg/ℓ within 61 m of the discharge pipe. Dissolved oxygen levels at all locations in the vicinity of the discharge remained at over 69 percent of saturation.

## Island Development

### Vegetation

Plant species colonized the new island rapidly. Willow and cattail seedlings and several species of annual plants grew on the island after dredging was completed in July 1983.

Lake elevation attained 292.4 m NGVD following spring runoff in 1984. Lake levels receded, and most of the island supported emergent vegetation, which became quite dense and was dominated by sticktights (*Bidens ceruna*), arrowhead (*Sagittaria latifolia*), cattail (*Typha* spp.), and willow (*Salix interior*). Unusually high lake levels occurred in July and August 1984, attaining elevation 292.8 m msl. The island was subjected to considerable erosion, removing all but a small patch of vegetation (Table 1). By October 1984, the island had reconfigured from a circular to a crescent shape (Figure 3). The crescent shape of the island is typical of an alluvial material island produced by wave action (Duane et al. 1975). The landward location of the island apparently prevented material eroded from the island from joining the littoral drift of sediment along the coastline. Material eroded from the island formed a semicircular shallow sand flat on the lakeward side. No vegetation occurred on the sand flat lakeward of the emergent portion of the island in 1984.

A dense bed of submerged aquatic plants developed landward of the island in the area protected from wave action. Pondweeds (*Potamogeton* spp.), *Myriophyllum exalbescens*, water buttercup (*Ranunculus* sp.), and water celery (*Vallisneria americana*) were the most abundant submerged aquatic plants occurring there.

By August 1987, wave erosion had further reduced the top elevation of the island to about 292.2 m NGVD, but the crescent shape of the island and the semicircular sand deposit lakeward of the island remained. Three small areas were emergent at lake elevation 292.0 m NVGD. A series of low dunes and swales developed on the sand flat lakeward of the island. Lake bed material between the low dunes was finer silt and peaty organic material. Submerged aquatic plants grew in these areas dominated by pondweeds, *Najas* sp., and water celery.

## Benthic Macroinvertebrates

Benthic macroinvertebrates had recolonized the dredged material deposit. Species composition and densities of macroinvertebrates approximated predredging conditions. Sensitive macroinvertebrates such as mayflies, caddisflies, and unionid mussels had recolonized.

## Bird Use of the Island

Birds made use of the dredged material island as a resting area as soon as material stacked up above the water surface at the beginning of the dredging operation. Volunteer observers reported 14 species of birds using the island in 1983. A total of 45 species of birds were observed using the island in 1984 (Table 2).

The most numerous birds on the island during 1983 and 1984 were ring-billed gulls, common terns, Franklin's gulls, white pelicans, double-crested cormorants, and herring gulls. Shorebirds occurred in groups of less than ten. As many as 472 birds were observed using the island at any given time.

Waterfowl used the protected shallow water landward from the island for feeding. Shorebirds fed on the flats exposed by falling lake levels. No birds were observed nesting on the island in either year.

# Conclusions

Open water discharge of dredged material resulted in temporary and localized water quality effects, and the dredged material was of such fine texture that it did not mound easily to form the island. This resulted in the island being built lower than originally planned.

At the same time, unusually high lake levels during the summer of 1984 inundated the island, and wave action reconfigured the island into a lower, crescent shape. Material eroded from the island did not remain in the littoral sediment drift along the lakeshore but was redeposited into a semicircular sand flat lakeward of the island.

High lake levels and wave action effectively removed all terrestrial vegetation from the island that grew in the first year. The dredged material deposit initially resulted in a net reduction in the areal extent of submerged aquatic plants, but aquatic plants subsequently recolonized much of the dredged material deposit, particularly between low lake bottom dunes that formed lakeward of the island. Lush submerged aquatic plants grew in the protected water landward of the island. Macroinvertebrates recolonized the dredged material deposit.

Birds used the island extensively for roosting, but no nesting occurred there. The shallow flats around the island were used by shorebirds as water levels declined. Waterfowl fed in the protected area landward of the island.

Deposition of dredged material to form the island has provided an opportunity to evaluate island building as a beneficial use of dredged material in a freshwater lake. Placement of dredged material in the littoral zone of larger lakes requires consideration of the substantial forces of wave action and sediment transport.

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Table 1

Vegetation on Warroad Dredged Material Island, 11 September 1984

| Plant Species | Percent Frequency n = 16 | Maximum Plant Height, m | Mean Density Where Present stems/sq m |
|---|---|---|---|
| *Bidens ceruna* | 87.5 | 1.2 | 19.7 |
| *Saggitaria latifolia* | 81.2 | 0.8 | 13.2 |
| *Typha* sp. | 68.8 | 0.3 | 23.6 |
| *Salix interior* | 56.2 | 0.75 | 18.2 |
| *Salix* sp. | 25 | 0.75 | 15.0 |
| *Scirpus validus* | 25 | 1.2 | 27.0 |
| *Eleocharis* sp. | 18.8 | 0.3 | 61.3 |
| *Juncus tenuis* | 12.5 | 0.3 | 8.0 |
| *Phalaris arundinacea* | 12.5 | 0.4 | 14.0 |
| *Polygonum hydropiper* | 6.2 | 0.2 | 4.0 |
| Unidentified broadleaf seedling | 31.2 | 0.02 | 212.0 |
| Unidentified grass seedling | 31.2 | 0.02 | 332.0 |

Table 2

Birds Observed on the Dredged Material Island in Lake of the Woods at Warroad, MN, During 1984

| | 4/28 | 5/2 | 5/3 | 5/6 | 5/12 | 5/17 | 5/20 | 5/22 | 5/26 | 6/3 | 6/7 | 6/9 | 6/11 | 6/13 | 6/18 | 6/24 | 7/7 | 7/19 | 7/28 | 8/11 | 8/17 | 8/24 | 8/30 | 9/5 | 9/9 | 9/11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| American white pelican | | | | | | | | | | | 30 | | 4 | 15 | | | 14 | 20 | 4 | | 6 | | | 2 | | |
| Double-crested cormorant | | | | | | | | | | | | | | | | | | | 25 | 35 | 35 | 25 | 250 | 11 | 13 | |
| Great blue heron | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Green-winged teal | | | | | | | | | | | | | | | | | | | | | | 30 | 25 | | | |
| Mallard | | | | | | | | | | | 2 | | | 2 | | 6 | | | 5 | 12 | 6 | | | 6 | 1 | |
| Blue-winged teal | | | | | | | | | | | 1 | | 1 | | | | | 10 | | | | 20 | 5 | 10 | 45 | |
| Northern shoveler | | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| Gadwall | | 2 | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | |
| American wigeon | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lesser scaup | 8 | 6 | | | | | | | | | | | | | | | | | | | | | | | | |
| Common goldeneye | | | | | | | | | | 6 | | 1 | 2 | | | | | | | | | | | | | |
| Bufflehead | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Osprey | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| American coot | 6 | | | | | | | | | | | | | | | | | | | | | | | 30 | | |
| Black-bellied plover | | | | | | | 2 | | 1 | | | | | | | | | | | | | | 10 | | | |
| Semipalmated plover | | | | | | | | | 2 | | | | 19 | | | | | | | | | 1 | 5 | 5 | 4 | |
| American avocet | | | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| Lesser yellowlegs | 2 | | | | | | | | | | | | | | | | | | | 1 | 3 | | 6 | 5 | | |
| Marbled godwit | | | | | | | | | | 2 | | | | | | | | | | 2 | | | | | | |
| Ruddy turnstone | | | | | | | | | 2 | 1 | | | | | | | | | | | | | | | | |
| Red knot | | | | | | | | | | 3 | | | | | | | | | | | | | 1 | 3 | 3 | 4 |
| Sanderling | | | | | | | | 6 | | 15 | | | | | | | | | | | | | | 4 | 2 | 2 |
| Semipalmated sandpiper | | | | | | | | | | | 2 | | | | | | | | | 3 | 4 | | 6 | 6 | 2 | |
| Least sandpiper | | | | | | | | | | | | 8 | | | | | | | | | 3 | | 6 | 6 | 4 | 1 |
| White-rumped sandpiper | | | | | | | | | | | 2 | | | 1 | | | | | | | | | | | | |
| Pectoral sandpiper | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dunlin | | | | | | | 12 | 6 | 2 | | | | 1 | | | | | | | | | | | | | |
| Stilt sandpiper | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Long-billed | | | | | | | | | | | | | | | | | | | | | | | | | 2 | |
| dowitcher | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | |
| Dowitcher sp. | | | | | | | | | | | | | | | | | | | | | 5 | 4 | 10 | | 1 | |
| Franklin's gull | | | | | | 40 | | | | 20 | | 2 | | | 250 | | | | 2 | | | | | | | |
| Bonaparte's gull | 2 | 6 | | | | | 1 | | | | | 1 | 2 | 50 | | 40 | 1 | 12 | 2 | | | | | 4 | | |
| Ring-billed gull | 425 | 200 | 300 | 200 | | 50 | 100 | 25 | 20 | 10 | 8 | | | 4 | | 3 | 1 | 45 | 70 | | | | 6 | | 3 | |
| Herring gull | 25 | | | | | | | 10 | 2 | 5 | 4 | | 5 | | | 10 | 4 | | 8 | | 1 | | 1 | 70 | | |
| Caspian tern | | | | | | 35 | | | 4 | | | | | | | | 2 | | 1 | 20 | 20 | 55 | 30 | | | |
| Common tern | | | | | | | | | | | 10 | 2 | | 10 | | 23 | | 15 | 40 | 90 | 120 | 35 | 30 | 160 | 125 | |
| Forester's tern | 2 | 6 | | 35 | 55 | 50 | 50 | | | | | | | 30 | | 17 | | | 5 | 10 | 15 | 15 | | 20 | 17 | |
| Black tern | | | | | | | | | 10 | | | 2 | | 2 | | | | | | | | | 1 | | 5 | |
| Killdeer | | | | | | | | | | | | | | | | | | | 1 | 55 | | 60 | 35 | 30 | 45 | |
| Spotted sandpiper | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 1 | | |


Figure 1. The location of Warroad, MN, on Lake of the Woods

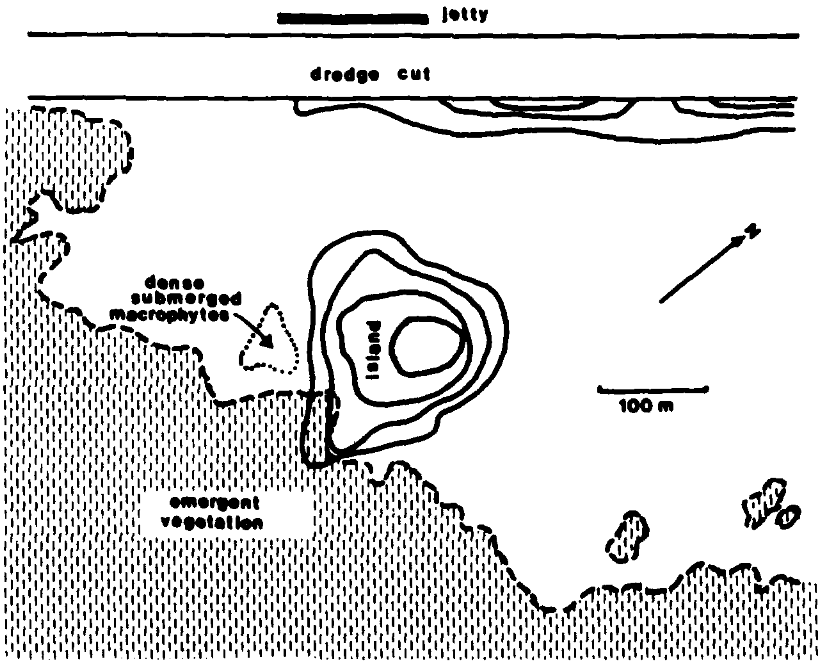


Figure 2. The dredged material placement site at Warroad, MN, on 13 July 1983

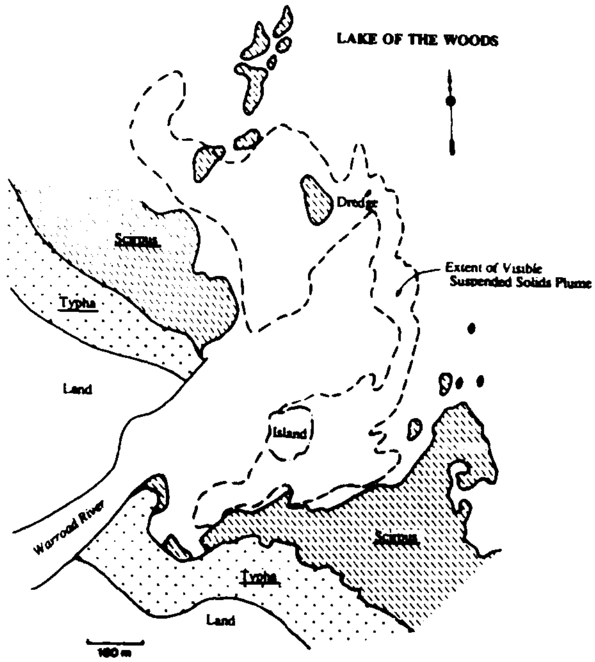


Figure 3. Suspended solids plume during dredging at Warroad, MN, on 25 June 1984

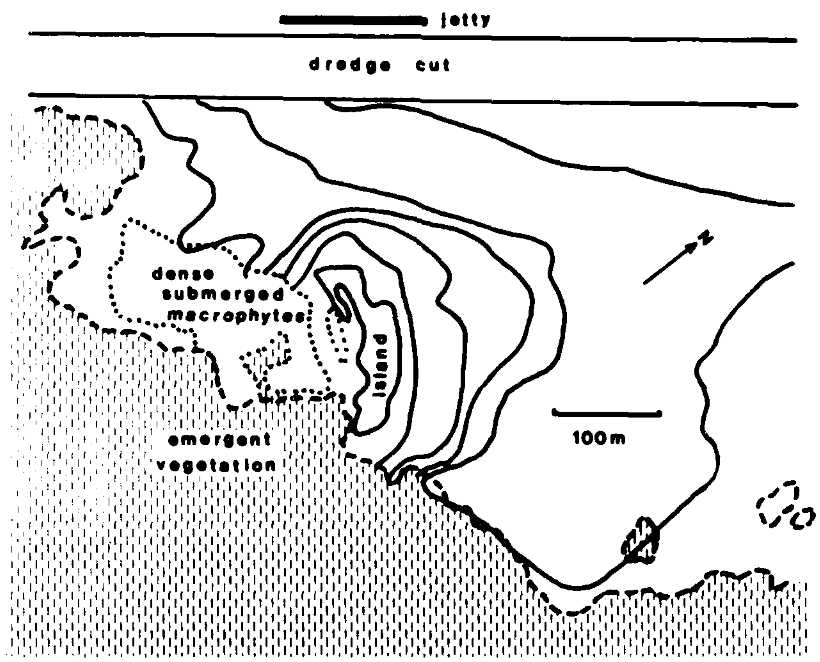


Figure 4. Dredged material placement site at Warroad, MN, on 1 October 1984

# SESSION I: AQUATIC HABITATS

## CLOSING REMARKS

Robert Barber
US Environmental Protection Agency
Kansas City, Missouri

I would like to close this very interesting technical session on aquatic habitats by posing three questions and some thoughts on each.

1. Is the existing technology applicable for aquatic habitat creation in all parts of the nation?

Known principles and concepts of aquatic habitat creation can be applied universally. However, care must be taken to evaluate the individual placement sites. In general, we know that gravel can be used to create productive aquatic habitat if the site is designed well. However, there is still a lack of knowledge about what aquatic invertebrate response will be in different ecological zones. This lack of knowledge should not discourage attempts to create aquatic habitat, but more monitoring may be necessary to assure success. Before attempting to create habitat with dredged material, it is necessary to evaluate the habitat values you expect to gain and to compare those values with the values of the aquatic habitat being replaced.

A general problem with monitoring is that there are usually limited or no funds budgeted for evaluation of the project success. There is a need for preproject interagency coordination, because of the differing mandates for various State and Federal agencies.

2. Is the known technology adequate to begin providing operational guidance to users?

Open water disposal will probably be more common in the future as existing disposal sites become filled and new upland sites become more difficult to find. As a result, aquatic habitat creation will need to be considered more often as a beneficial use option. However, a major obstacle in considering this option is our inherent fear of failure and reluctance to try something new. Local demonstration projects have proved to be useful in overcoming this resistance to new technologies.

Dredged material placement technology is now available for aquatic habitat creation. However, while engineering techniques are well known, there is still a need for additional knowledge about the efforts on targeted organisms. In considering aquatic habitat creation with dredged material, it is helpful to realize that aquatic habitats are transient and the habitat created initially will eventually evolve in another habitat. The rate of evolution will depend upon the location, hydrology, and biota of the site.

There is now a need to go beyond the trial stage and develop policy direction on aquatic habitat creation using dredged material. Guidance on

evaluating the potential for aquatic habitat creation may stimulate interest and ease concerns for this little used beneficial use.

3. Can benefits be qualitatively and quantitatively assessed?

Biological benefits can be qualitatively assessed with existing technology. Quantitative evaluation is more difficult. While physical costs and benefits are fairly easily quantified, biological benefits are generally not easily quantified. Values society places on certain species or habitats may be different than the actual ecological values. However, because environmental issues compete with cost issues in dredging activities, there is a need to quantify the habitat benefits. More emphasis is needed on developing techniques for assessing the monetary benefits of creating habitat and for assessing relative habitat values.

# DINNER ADDRESSES

## DREDGING NEEDS AND THE CALL FOR INFORMATION

BG Peter J. Offringa
Deputy Director of Civil Works
Office, US Army Chief of Engineers
Washington, DC

Thank you, I really appreciate the opportunity to be with you tonight and to meet with all of you during this very important conference on the beneficial uses of dredged material in inland waterways. After listening to many of you talk today, I realized that some of the beneficial use examples from the CE that I was going to talk about are already "old hat" to you and that you are way beyond me on this.

I have decided to change the thrust of my talk a little bit, and I want to talk about some of the things I think are important in terms of the needs we have in the CE and in our dredging program where we need your help. I also want to talk about how innovation is important, and I want to talk about how critical our actions are. Before I do that, I want to tell you what a pleasure it is for me to be in St. Paul, MN, the Garden State and the home of new World Champion Twins. It's great to be in the midwest and in the heartland of America!

You are very important people---you are important because you have the very important job of serving the citizens of the US by assisting and providing good, innovative, and bright ideas on how we will deal with dredged material that we have to move when we maintain the critical commerce and strategic waterways of this Nation. I am impressed with the papers I have heard today, and the tremendous range of talents and abilities I have seen. I am impressed by your dedication to wrestle with this challenging problem and your technical tasks with far reaching impacts. I am impressed with the broad cross section of capabilities of people I see here who are interested in dredging, from the CE, from industry and ports, from State and other Federal agencies, from local and county groups, from academia, and from private environmental and citizens' groups. When we focus on a common purpose, there is nothing we cannot accomplish! I am also very optimistic. I saw a lot of good work today out on the Mississippi River and the results of your hard work and cooperative efforts.

I want to talk about needs. There is a tremendous need for your capabilities. We have a dredging program that is huge and is growing. We have 25,000 miles of inland waterways, 400 harbors and ports to maintain, and more than one billion dollars invested in an annual dredging budget. It is very important to our Nation's economy--it is very important to our Nation's defense. We move over two billion tons of waterborne commerce through our ports each year. It is critical that we keep this moving smoothly and safely. Waterborne related jobs represent one in every five jobs in the US, so it is important to the individual well-being of our Nation's citizens. In addition, a lot of the agricultural and other exports our Nation sells overseas are moved through our inland waterways.

Secretary Doyle talked about the WRDA. He mentioned that the CE has a new charter on water projects that include 9 inland waterway, 115 flood control, and 23 harbor construction projects, including big-time jobs like Baltimore, Kill van Kull, Norfolk, Mobile, New Orleans-Baton Rouge, Galveston, and others. This alone will increase our dredging requirements by one billion cubic yard over the next ten years.

Our national defense imperative, dredging and channel maintenance, is critical to ensuring our Nation's readiness. Homeporting of our US Navy fleet, the ability to rapidly transport large quantities of material and manpower overseas, and the use of the inland waterways to transport equipment and supplies all demand that we keep our navigational responsibilities well in hand.

We have new players to work with as partners and to educate now that cost-sharing is a fact of life. With local sponsors having to share in project expenses, the least costly alternative to project construction and maintenance will be even more closely examined. It will be harder to justify beneficial uses in projects to our sponsors unless these uses lessen the cost of the projects.

So, we have all these needs and charges that are important to the success of our national economy and defense. The only way we can meet these needs is through the application of innovation by bright, creative people such as yourselves. That is really the purpose of this conference, you know---to exchange ideas and to generate creative thinking in ways to use dredged material to best advantage.

You have generated all sorts of unique and productive ways to use dredged material. As I listen to these, I would feel remiss if I don't mention our distinguished dean of dredging, Bill Murden, the creator of "Murden's Mounds" or "Bill's Berms," as the concept is sometimes known. These underwater berms use large quantities of dredged material to buffer storm actions, to add to the littoral drift system along shorelines for beach nourishment and shoreline stabilization, and to provide marine and fisheries habitat.

I was told how dredged material is used to create islands such as Gaillard Island, a 1,300-acre confined disposal facility island in Mobile Bay, which is now home to over 25,000 nesting seabirds, including hundreds of endangered brown pelicans. It also has recreational use and is providing more wetland, beach, and shallow water habitat in the Mobile Bay.

Chesapeake Bay is the site of numerous beneficial use projects involving dredged material, including those such as Barren Island, a combination of wetland, seabird nesting, and seagrass habitat. We've used dredged material in the Bay to regenerate oyster and fisheries production and improve water quality and in numerous wetland development projects.

There is also the shrimp farm we have built as a demonstration at Brownsville, TX to show that disposal facilities between dredging cycles can be profitably used for aquaculture. In the first year alone, we have harvested and sold 140,000 lb of shrimp, and the second year promises to be even better. This project was one we designed to pay for itself, and one of its

objectives was to prove that it could. If it cannot, then it will not be viewed by the CE as successful.

I'm sorry that I did not get to Weaver Bottoms with you yesterday, but I understand that it is a tremendous example of dredged material use right here in the St. Paul District. There are many, many more examples---building highways, providing sand for ice control, erosion control, gully fill, agriculture and forestry enhancement, construction and maintenance of recreational areas. Beneficial uses is a great concept! So you can see why I say that you are providing a tremendous service to the public good in the role you play and in generating these thoughts and initiatives.

Don't stop now. I urge you to continue the process---the benefits to all of us are great. My first advice to you is MORE INNOVATION--crank up the brain power! Keep the ideas coming and use dredged material as a natural resource. Think of more and better ways to put it to use. If you will brainstorm together, as you have been doing here, the Nation will reap the benefits. Don't be afraid to beg, borrow, and use good ideas, and pass them along to others who will use them!

My second advice to you is EXPLOIT EXISTING TECHNOLOGY wherever possible. Apply it to your work. Use it as a launching pad for modifications and developments that will further expand the potential for beneficial uses.

Third, EDUCATE. There is a great need to educate the public in terms of what we are trying to accomplish. There is also a great need to teach them that dredged material does not equal "bad" material. I have come across the perception so many times in my work that anything off the bottom of the bay or river or lake has to be bad when we know that most of what is brought up is basically clean sediment suitable for use in many ways. After all, dredged material is just misplaced soil. It is not enough for us to know that---we have to see that the public knows that so that we can get on with the work of maintaining our Nation's waterways, ports, and harbors.

As Bill has said, we have to clean up our language! One of the problems we have is bad terminology---terms have perceptions, and in our business, perceptions sometimes become realities. We use words like "dumping," "disposal," "dredging up," "spoil," and others when we should be talking about "placement," "containment sites," "excavation," "dredged material," and "beneficial uses," After all, over 90 percent of what we dredge is clean enough to put on your lawn or your flower garden or your child's sandbox.

Words are important because we are talking about over 400,000,000 cu yd a year. This resource is enough to bury Washington, DC, to a depth of 6 to 7 ft. When I told that to a few people, they all suggested that that would be the most beneficial use of all! Use the correct terminology!

My final charge to you is to work together and to continue your interaction. I commend what you have accomplished, and I am looking forward to seeing more of this kind of work in the future. After all, all of you agency people, as well as I, work for the American taxpayers. Anything we can do with dredged material, the natural resource, NOT dredged material, the waste product, that will benefit our citizens and our Nation and improve our economy

and national strength is a very positive and highly important service. Keep up the good work!

## SESSION II: HABITAT DEVELOPMENT CASE STUDIES

### OPENING REMARKS

Hollis H. Allen
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

Bruce Stebbings
US Fish and Wildlife Service
Marion, Illinois

Yesterday you heard about habitat development from an aquatic perspective. In this session, we will be covering habitat development case studies focusing on upland and wetland projects. There are hundreds of examples of these types of habitats built on dredged material sites, and the four projects you will hear about today only reflect some of the habitat development that is occurring in inland waterways.

Much of this type of habitat development has occurred in intracoastal waterway and estuarine projects, but with 25,000 miles of inland waterways to maintain, our CE Districts have great opportunities to plan and implement such beneficial use activities. You have already seen Weaver Bottoms, a classic habitat restoration example in the Upper Mississippi River, a Lake of the Woods, a cold region wetland development project on the Canadian border.

You will hear later today about numerous examples of habitat development in the Great Lakes, especially in confined disposal facilities. You will also hear in another session about the potential for habitat development in the Pacific Northwest inland waterways. These and numerous other projects, as well as the four case studies you will hear about now, are providing habitat for various species of wildlife at locations throughout our inland waterways.

There is no question that dredged material itself can be treated as a natural resource. It can be used for mitigation efforts and in numerous other ways with regard to natural resource development and management. However, whether dredged material can be used beneficially and as a natural resource is in direct proportion to the degree of cooperation between the various agencies and professional disciplines involved.

We have witnessed this in every paper given at this conference. We now know that we can have it both ways---good engineering designs and cost-effective implementation of projects, AND good habitat development and management---if people will just work together for a common purpose.

SESSION II: HABITAT DEVELOPMENT CASE STUDIES

# UPLAND HABITAT DEVELOPMENT ON DREDGED MATERIAL PLACEMENT SITES, UPPER MISSISSIPPI RIVER, POOL 18

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US Army Engineer District, Rock Island
Rock Island, Illinois

## Introduction

Disposal of dredged material from Mississippi River 9-ft channel maintenance activities is a problem biologists and engineers have been attempting to solve for several years in GREAT I, II, and III. Since dredging for the 9-ft channel began in the 1930's, dredged material has been placed in many locations and habitats along the river.

In the past, and less frequently today, material often was placed in bottomland hardwoods in a permanent stockpile. Characteristically, most trees buried to a depth of more than 6 ft died within 1 to 2 years, leaving a sterile, unvegetated sand mound. Natural revegetation (succession) of these sandpiles is extremely slow or nonexistent. Some sites that were used only once in the 1940's and 1950's still remain mostly devoid of vegetation. Lack of nutrients and water and frequent summertime surface temperatures of 120° F or higher make very harsh growing conditions for even the most drought-tolerant species.

Many investigations have studied and promoted various methods of establishing vegetation on "spoil" lands impacted by strip-mining or dredging activities. Efforts in all of these studies were usually directed toward overcoming a multitude of detrimental soil properties, such as low pH, toxic metal compounds, low nutrients, etc. Few of these studies seriously attempted to revegetate soils composed of 100 percent medium- to coarse-grained sand.

Howe (1979) studied the natural succession which occurred on 15 Mississippi River disposal sites ranging in age from 0 to 28 years of age, and he found that "soil moisture was determined to be the most influential factor affecting vegetation and plant succession on dredge spoils." The primary goal of this investigation was to develop vegetation establishment techniques for these sandy soils.

Bell and Ungar (1981), in studying succession on strip-mined lands in Ohio, also concluded that soil moisture, along with soil temperature, was the most important factor affecting plant establishment on disturbed soil. Consequently, a major part of this study was to investigate various methods of enhancing soil moisture retention and of lowering soil temperatures.

## Study Objective

Although these sand piles provide important recreational benefits, it is desirable that some of these sites be revegetated to replace habitat lost from disposal. Since 1981, the Rock Island CE District has been experimenting with various planting techniques that can be used to readily establish a vegetative cover on these sites. Study objectives were to:

a. Develop a method that uses a minimum of mechanized equipment and that can be used in inaccessible locations such as river islands.

b. Develop "foolproof methods" that could be implemented by anyone with a minimum of instruction.

c. Ultimately revegetate sites with native species that provide food and shelter for wildlife.

d. Develop a variety of revegetation methods that can be used to meet the characteristics or management objectives of a particular site.

## Study Sites

Investigations were conducted in Mississippi River Pool 18 near Keithsburg, IL. This area has been frequently dredged in the past and provided several unvegetated dredged material disposal sites in close proximity.

### Dredged Material Characteristics

Practically all Upper Mississippi River dredged material placement sites are composed of medium- to coarse-grained sand deposited by the hydraulic cutterhead dredge WILLIAM A. THOMPSON. The large volume of water generated by the dredge carried away almost all of the suspended sediments and other organics associated with the in situ dredged material. Soil analysis of dredged material indicated organic contents ranging from 0.1 to 0.83 percent and silts and clays ranging from less than 1.0 to 5.0 percent. By comparison, native sand prairie had organic contents ranging from 1.0 to 2.32 percent and silt/clay contents of 6 to 8 percent. Surface temperatures of placement sites often exceed 140° F in summer. Subsurface temperatures at 2 in. deep also have been measured at plus 100° F.

## Experimental Planting Methods

A variety of species and planting techniques have been studied since experiments started in 1982. Woody shrubs, grasses, and forbs were all used. This paper will only discuss the results of the mulch comparisons, topsoil capping, American beachgrass transplants, and prairie sod transplants.

Initial attempts at seeding grasses and forbs without mulch were unsuccessful. When germination did occur, seedlings did not survive. Even shrubs that were planted using moisture-retaining amendments failed to produce new growth or survive. Consequently, efforts were directed at finding out which mulches should be used.

Broadcast Seeding with Mulch

Three experimental vegetation plots were established on Blackhawk Island in October 1983, one week after dredged material placement. The purpose of these plots was to compare the relative effectiveness of various mulches and artificial ground cover in establishing a permanent grass cover. Straw, cut willow saplings, and snow fence were used in three separate plots. Excelsior blankets and wood fiber erosion control mats also were used on a fourth plot, but they were not laid and seeded until May 1984. The four plots were fertilized at that time with 50 lb of 12-12-12 and 15 lb of 30-4-4.

Snow Fence

Switchgrass, sand lovegrass, sand dropseed, smooth brome, yellow sweetclover, and birdsfoot trefoil were seeded by hand with a cyclone seeder over a 1,600-sq-ft plot at a rate of 82.5 lb of seeds/acre. The site was then raked and eight rolls of snow fencing (4 by 50 ft) were laid over the plot and partially suspended above the ground surface by means of willow stakes. Approximately 12 man-hours were required to suspend the fence and spread the seeds.

Willow Mulch

Switchgrass, birdsfoot trefoil, yellow sweetclover, sand lovegrass, sand dropseed, and smooth brome were seeded on a 3,200-sq-ft plot in October 1983 at a rate of 82.5 lb/acre. The plot was then raked and covered with freshly cut willows from the adjacent willow thicket. Approximately eight man-hours were required to cut willows and cover 50 to 60 percent of the ground surface.

Straw Mulch

Switchgrass, birdsfoot trefoil, yellow sweetclover, sand dropseed, little bluestem, and smooth brome were seeded on a 3,200-sq-ft plot in December 1983 at the rate of 82.5 lb/acre. Eleven 50-lb bales of straw were spread over the seeded area to provide a 100 percent ground cover. Baling string was strung across the straw in a crisscross pattern and staked to the ground to prevent straw from blowing away. Six man-hours were required to install the plot.

Excelsior Mat

Switchgrass, birdsfoot trefoil, yellow sweetclover, sand dropseed, little bluestem, and smooth brome were seeded on a 3,150-sq-ft plot in April 1984 at a rate of 82.5 lb/acre and covered with five 70-sq-yd rolls of excelsior mat. Four man-hours were required to spread seeds and lay the blankets of excelsior.

## American Beachgrass Plantings

American beachgrass has proven to be an excellent species for stabilizing sand dunes (Carroll 1973). It thrives on sites where other vegetation is sparse and extreme growing conditions are present. Although beachgrass has little value for wildlife, it provides good cover and may serve as a nurse crop for establishment of more valuable native species.

Two separate plantings of American beachgrass were made with one being planted in May 1984 on an old disposal site on Island 189 at River Mile (RM) 610 and the other being planted in Pool 18 in October 1984. Beachgrass was obtained from the Mason Lake Soil Conservation District in Scottsville, MI. Sprigs in both planting locations were spaced on 2-ft centers.

## Prairie Sod Transplantation

The purpose of this experiment was to determine the practicality of transplanting sod from an established prairie directly onto dredged material. A 2-acre disposal site was planted in April 1987 with prairie sod plugs of little bluestem and Indian grass. Three sizes of plugs (8 by 15 cm, 15 by 20 cm, and 20 by 20 cm) were planted on 4- and 6-ft centers. After transplanting, the site was also seeded with Indian grass and little bluestem at a rate of 15 lb/acre PLS. The site was covered with straw mulch at a rate of 1.5 tons/acre and sprayed with an asphalt tackifier to hold the straw in place.

## Topsoil Capping of Dredged Material

In 1984 and 1985, dredged material was placed on approximately 5 acres of a forest management clearcut at RM 425.9. Prior to dredged material placement, approximately 80 cu yd of topsoil was scraped from the site and stockpiled. Following the 1985 disposal, the stockpiled soil was spread over half the site using a dozer. The other half of the site was done in 1986. Approximately 40 hr of dozer time was required to grade half the site and to scrape and spread the soil. Soil thickness varied from < 1 to about 6 in. deep due to the difficulty of spreading the soil.

Using cyclone seeders, the soil-enriched portion of the site was then seeded with field rye at a rate of 150 lb/acre in preparation for planting the site with native grasses the following spring. Two weeks following seeding, 3- to 5-in. rye seedlings were present over the site, except for patches of bare sand that had no soil. Inspection revealed that the rye which fell on sand devoid of soil had germinated but soon died.

On 8 May 1986, the site was seeded with Blackwell switchgrass at a rate of 20 lb/acre. The previously planted rye was 4 to 5 ft high when the switchgrass was seeded. The remaining 2 acres of the site were covered with approximately 90 cu yd of soil in May 1986. A mix of little bluestem, big bluestem, and Indian grass was planted by cyclone seeder in October 1986 on these 2 acres at a rate of 7.5 lb/acre for each species. Because of the volunteer weeds growing on the site, incorporating the seeds into the substrate turned out to be impossible.

## Results

### Mulch Planting

Two years after seeding, a well-established stand of grasses was growing on 3 of the 4 mulch plots. Surface coverage of the straw mulch plot was 40.8 percent when inspected in September 1985, compared to 30.9 percent for snow fencing and 15.7 percent for willow (Table 1). There was practically no growth on the excelsior mat plot. There was an apparent decline from the previous year when seedlings were visible among the mat fibers throughout the plot. Smooth brome accounted for more than 95 percent of the total grass present on all plots.

There was a very distinct demarcation between the untreated control areas surrounding each plot and the seeded/mulched plot. Even though seeds were spread beyond the border of each plot as a control, there was no grass survival outside of the mulch zone. When the plots were inspected for germination success in May 1984, seedlings were fairly evenly distributed over the entire plot of each mulch type except for the excelsior mat. At this time, there was still 100 percent coverage of mulch on the straw plot and a considerable amount of willow debris on the willow mulch plot. In 1985, however, the straw had blown away from the edges of the plot, and only branches remained on the willow plot. It was very evident that the grass cover was much more dense on the interior of the straw plot; density had decreased from the previous year on areas where the straw was missing.

Grass cover on the willow mulch plot also was distributed unevenly compared to the previous year. The most dense growth was near the thickest branches and accumulation of willow debris. Grass was very sparse or nonexistent in areas where there were no branches or debris. The plot with the snow fence cover had the most evenly distributed coverage.

The plot having the highest seed germination in 1984 was not the plot with the highest percent of coverage in 1985. The snow fence plot was by far the most successful in seed germination (69 stems/sq m) but fell below the straw mulch percent cover the following year.

Aboveground vegetative cover was still well below the typical height of a mature stand. The smooth brome did not exceed 12 to 20 in. in height whereas this species normally reaches 3 to 4 ft in good soil. An excavated cross section of the straw plot showed an extremely well-developed root system that extended at least 12 in. below ground surface.

### Beachgrass Plantings

Beachgrass plantings on Island 189 were unsuccessful. Inspection of the site several weeks after planting showed that all sprigs had died soon after planting. Dead sprigs had no evidence of root growth.

The November 1984 beachgrass planting in Pool 18 was extremely successful. There was virtually no mortality of any sprigs when the site was inspected the following spring. Subsequent inspections during the summer and

fall of 1985 showed that plants were already spreading vegetatively by stolons. Whether planted in direct sunlight or semi-shade, all plants appeared to be achieving a similar growth rate.

### Sod Transplanting

Survival of the sod varied with the size of the plug and the species contained within the plug (Table 2). Following transplanting, there was low rainfall for the next 3 months. Considering that air temperatures exceeded 90° F often that summer, with almost no moisture, it is surprising that any plugs survived. The larger plugs of Indian grass had a 96 percent survival rate and was better than any other plot or plug size. Little bluestem plugs fared considerably worse with only a 32 percent survival rate.

### Topsoil Capping

Two years after seeding, the 2.5 acre portion of the site seeded with switchgrass had achieved a cover ranging from 37 to 74 percent. Greater than 70 percent of the cover was composed of switchgrass. The great variability in cover was related to the amount of topsoil actually placed over the sand. The southern end of the site had the deepest soil and most even cover and averaged 74 percent plant cover. The northern end, where some bare spots devoid of topsoil were left, averaged only 37 percent cover.

## Discussion and Conclusions

The results of the above field tests and other experiments not discussed in this paper indicate some quite obvious conclusions. If any seeding of coarse-grained sediment is to be successful, a mulch of some type is mandatory. Any type of mulch that lowers surface temperatures, decreases blowing sand, and helps retain soil moisture will greatly improve chances of success. Too dense a mulch, however, as evidenced by the excelsior mat, will inhibit growth.

As beneficial as mulches are, they do very little to actually improve the fertility of the sandy dredged material. This is why the incorporation of even a small amount of topsoil appears to greatly enhance the rapid establishment of native grass stands. The benefits of adding topsoil come at a higher cost per acre, and this technique is not practical for all sites. Locating a suitable nearby borrow source of topsoil is a frequent problem. The least expensive and most effective means of revegetating a site is to plant American beachgrass sprigs. Beachgrass has very little wildlife value, however, and tends to die out as areas of bare sand disappear. Prairie sod transplantation can revegetate a site overnight, but the technique is impractical for sites over 1 to 2 acres in size. Because of the variety of site conditions encountered in the Upper Mississippi River, it is desirable to have an array of revegetation techniques from which to choose the best method for individual site restoration.

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Table 1

A Comparison of Cover Mulch Type on Blackhawk Island

| Species Seeded, No./Acre Seeded | Straw | Willow | Snow Fence | Excelsoir Mat |
|---|---|---|---|---|
| Switchgrass | 15 | 15 | 15 | 15 |
| Sand lovegrass | -- | 7.5 | 7.5 | -- |
| Sand dropseed | 15 | 15 | 15 | 15 |
| Smooth brome | 15 | 15 | 15 | 15 |
| Yellow sweetclover | 15 | 15 | 15 | 15 |
| Birdsfoot trefoil | 15 | 15 | 15 | 7.5 |
| Little bluestem | 15 | -- | -- | 15 |
| Total acres seeded | 90 | 82.5 | 82.5 | 82.5 |
| Size of plot ($ft^2$) | 3,200 | 3,200 | 1,600 | 3,200 |
| Man-hours required to prepare site | 4 | 8 | 12 | 3 |
| Date seeded | 12/1/83 | 10/19/83 | 10/18/83 | 4/19/84 |
| pH as measured on 10/18/83 | 6.9 | 6.9 | 6.9 | 6.9 |
| Soil moisture 10/18/83, % | 6-9 | 7 | 6 | 4-7 |
| Germination on -3m$^2$ plots (No. seedlings/m$^2$) 5/11/84 | 20 | 16 | 69 | <1 |
| % ground cover* measured 9/11/85 | 40.8 | 15.7 | 30.9 | <1 |

* Smooth brome accounted for >95% of all ground cover on all types of mulch.

Table 2

Percent Survival of Prairie Sod Plugs Planted in Dredged Material

| Plot | Plugs* | Percent Survival, October 1987 India Grass | Little Bluestem |
|---|---|---|---|
| 1 | 100<br>8 by 15 cm | 11 | 3 |
| 2 | 50<br>8 by 15 cm | 12 | 2 |
| 3 | 100<br>15 by 20 cm | 85 | 18 |
| 4 | 50<br>15 by 20 cm | 82 | 18 |
| 5 | 100<br>20 by 20 cm | 81 | 32 |
| 6 | 50<br>20 by 20 cm | 96 | 24 |

* No. of plugs of each species planted in April 1987.

QUESTION: What was the seeding rate you used?

MR. DUYVEJONCK: It varied from 80 to 90 lb/acre of pure live seeds where mulches on sand were used. Where we used just mulches, we needed the higher seeding rates and used more pounds per acre. Where we incorporated topsoil into the dredged material, we needed only 20 lb/acre.

QUESTION: Is there any possibility of incorporating cattle manure into sandy dredged material? I know that there is usually a ready supply of it at farms in the midwest.

MR. DUYVEJONCK: We are considering it, but we haven't used it yet. Even if you could get a supply from a nearby farm at little or no cost, you still have the cost of transporting and spreading it. If it isn't already dried out and pulverized, it's hard to work with.

SESSION II: HABITAT DEVELOPMENT CAST STUDIES

# WETLAND AND UPLAND WILDLIFE HABITAT DEVELOPMENT ON DREDGED MATERIAL DISPOSAL AREAS ON THE TENNESSEE-TOMBIGBEE WATERWAY

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## Background

Thank you for the opportunity to come to this conference to talk to you about the work Mobile CE District is doing on the Tennessee-Tombigbee Waterway (TTWW), particularly in the area of wildlife habitat development and management on dredged material. I work out of the Columbus Area Office as the TTWW project wildlife biologist.

The TTWW is a 234-mile navigation link between Pickwick Lake on the Tennessee River and Mobile Bay, via the Tombigbee, Alabama, Black Warrior, and Mobile Rivers. There are ten locks and dams and three main sections, the river, canal, and divide. Skeeter McClure will give you more details on environmental considerations and design of the TTWW in his paper later. I will mention that navigation is the first consideration in the TTWW, but conservation and natural resources is the second consideration. We work with both game and nongame wildlife and manage for both consumptive and nonconsumptive use of the TTWW. The third consideration in the TTWW is water and shoreline recreation.

The TTWW was authorized in 1946; construction was begun in 1970, and it was completed in 1985. The TTWW was the most environmentally scrutinized public works project the CE has ever built. It was built following NEPA guidelines. Mitigation is a very real part of the project. In fact, carrying out this mitigation is probably the primary reason for my job!

Mitigation in the TTWW is intensive management of 72,500 acres of project land for fish and wildlife, 14,000 acres of which are in disposal sites. Dredged material management is a significant part of our mitigation work. We are trying to raise the level of management on the entire area. We are also charged with intensively managing 20,100 acres on three other project for fish and wildlife within the Mobile District.

When disposal areas for dredged material on the TTWW were sited, location was given careful consideration. A number of the disposal areas were designed to be used only during construction and not for maintenance dredging. Therefore, we don't anticipate many changes in there except plant and animal succession. There are a number of disposal sites that were used in construction that will also be used for maintenance dredging, and we work with those to establish and maintain upland or wetland habitat. These disposal areas are located in highly erodible soils, and some of them are very diverse. They

range from very high, dry sites to low, wet sites. The sites have 50-yr storage capacities if they are needed for maintenance dredging. Most of them are compartmentalized, with dredged material being placed in the primary cell. The slurry then filters through to the secondary cell as it drops its sediment load, and the effluent goes out through permanent weir structures in the secondary cells.

When I look for a spot to establish wildlife habitat in a disposal area, I first make sure a functioning weir box is in place. Some were taken out of secondary cells, and it is hard to manage these disposal areas without one. It is now mandatory that they be left in place after dredging.

## Habitat Development and Management

### Intensive Management

The District's wetland development in the TTWW is actually waterfowl management in seasonal wetlands. We are trying to provide food for overwintering waterfowl and nesting geese on the TTWW. We have ten large stable pools that don't provide a lot of food for dabbling ducks---fluctuating water levels do this best. However, some of the pools are starting to develop good stands of aquatic plants that are used by diving ducks. We offset the lack of food for dabblers by intensive management of our disposal sites. We use the active disposal sites for interim management between dredging cycles. These sites vary from year to year.

We tend to use the secondary cells in the disposal sites for active management sites. Material placed in the primary cell is generally coarser-grained material whereas the material that stayed in suspension longest, the fine-grained sediment, tends to be what we find in the secondary cells. This silt material is much more productive, and we can generally manage the water easily in the secondary cells with the weirs.

We cultivate the sites and plant soybeans, corn, millets, and other crops. After seeds mature, we pump in 12 to 24 in. of water in November using small pumps on barges, frequently a Mud Cat dredge. It takes us a couple of days to get the water to the depth we need for dabbling ducks. These areas are extremely productive, and this particular effort is highly rewarding because of the wildlife we find using the areas.

In other disposal areas, we diversify crops. We will plant sorghum, corn, browntop millet, Japanese millet, and tuft-leaf millet. The secret to success on silt material is getting crops planted early so that they mature in midsummer before the silt dries out. The crop stands all summer for other wildlife to feed on before we pump in water in the fall for overwintering waterfowl. Another good crop producer we like to use is German foxtail millet. It is very hardy and prolific and produces 2,000 lb of seeds/acre.

Some of the dredged material is extremely productive, especially those that are fine silty-sands. We also plant corn, and we put about 400 lb of

complete fertilizer on our corn crops to ensure production. This is expensive, but the mitigation requirements call for this level of production.

## Passive Management

We do what we call passive management on lower quality sites. These are potholes and borrow areas created from dredging and primary cells. Typically, these don't drain well, and water fluctuates seasonally. We will hand seed or aerially seed the mud flats around the potholes and borrow areas with Japanese millet as the water levels drop. With this species, no cultivation or fertilizer is required, and these areas become extremely productive.

These efforts are highly cost-effective. We get a lot of utilization of these areas by overwintering waterfowl, upland game, turkeys, white-tailed deer, and Canada geese. We have a resident flock of Canada geese that we introduced to project land that really like these disposal areas. They especially use potholes and borrow areas for nesting. Each pair of geese picks out its own little pond and raises its brood on that pond.

Another level of management is even more passive, what we call moist soil management. It costs less and we do more of it, but it provides a lot of food productivity for wildlife. These areas pond seasonally and leave mud flats. These areas tend to grow with emergent marsh vegetation as fast as the water recedes. The soil is probably the reason for this rapid revegetation. Highly silty soils tend to revegetate rapidly during seasonal natural or manmade drawdowns. Generally, the plants that grow naturally on these areas are good for waterfowl---smartweeds (especially nodding and Pennsylvania), red-rooted sedge, chufa, and others.

## Other Wetland Management

Most of our disposal sites are multiple cells. We are now holding one cell in any dredging cycle full of water rather than letting it run out the weir box. This gives us two options: (a) we can plant the other cells with food crops and then pull the weir gates on the holding cell to flood our food crops; and (b) we can encourage wetland community development in the holding cell by virtue of the standing water. When we draw these holding cells down a year later, we find that they colonize quickly with natural wetland and wildlife plant foods. We are still testing these options, but they appear to have tremendous potential. They also cut our costs of seasonally flooding the overwintering areas by reducing the need for pumps.

Wood ducks are my pet project. We have 1,400 duck nesting boxes on project land, and a lot of them are on disposal areas. These areas provide great brood habitat for wood ducks. We haven't conducted a study yet comparing disposal area use to other project land use, but utilization of our disposal area nest boxes is around 40 to 45 percent so far.

## Upland Management

I want to shift gears here and talk about the upland management we do in the divide section. We plant agricultural crops in the disposal area there, and the sites are large and homogeneous. We stabilized the soil after

dredging was complete years ago by seeding mixed grasses and forbs. Native plants are not providing much wildlife food here because our seeding mixtures (sericea lespedeza, Kentucky fescue, lovegrass, and others) are outcompeting any native plants trying to come into the disposal areas. So, we plant agricultural crops and food plots here.

There are still people who have doubts about the value of food plots for wildlife. There's still a lot of research going on now at Mississippi State University on this, but I personally see a lot of utilization by white-tailed deer, turkey, bobwhites, and other animals on these plots. They are definitely providing a lot of food, and we are seeing population increases because of them. Also, these plots have most definitely provided good public relations for the District. The public sees these food plots, and the wildlife use they receive and they love it. It's funny, but some of the more effective management techniques are controlled burns and thinning, but the hunters don't see this. We can tell by our seasonal user surveys because they always tell us to plant more food plots!

In some of our divide disposal areas, the soil will appear to be unproductive. However, plant them in millet or other wildlife foods, and they do great. Getting them planted early is the key. We have tried planting later at the recommended planting time for these crop varieties and lost our crops due to the droughty conditions later in the summer. We always plant in February and March if we can on disposal sites. We have planted chufa on sandy sites and browntop millet on silty sites.

Some of our disposal sites are several hundred acres in size. We plant perennials on these sites, such as woody shrub stands of autumn olive, bicolor lespedeza, sawtooth oak, Chickasaw plum, and other prolific and early mast and seed producers. We leave travel lanes through these sites for wildlife to pass, but breaking up the large disposal areas with habitat diversity adds greatly to the use of the site. They become much more attractive to wildlife, and the shrubby stands provide food and cover.

Cavity Nesting Bird Management

The early successional stages that are found on disposal areas provide great bugging habitat for cavity nesters, turkeys, and other birds. Cavity nesting birds have a great need for nesting sites because clean agricultural and forestry practices don't leave many fence posts and snags. It is a limiting factor for many species.

We have put up nesting boxes, several hundred on some disposal areas, for cavity nesters and found up to 75 percent utilization by flycatchers, titmice, eastern bluebirds, prothonotary warblers, wrens, flying squirrels, and other nongame cavity nesters in the same year the boxes were put in place. There is definitely a scarcity of nesting sites for cavity nesting birds, and we are trying to correct this. We will continue to do this until we either saturate the habitat with boxes or get the natural vegetation up to where the habitat will provide cavities for nesting on its own.

## Bobwhite Management

We have tried controlled burns on disposal areas in the divide section. These disposal areas are leased to the State of Mississippi Department of Wildlife Conservation (MDWC), and their primary interest is management for small game, particularly bobwhites. The MDWC tried to maintain early successional stages. They do this by controlled burns. A burned area looks bad after it is first burned, but the food crops quail love are fire-adapted. The lespedeza and partridge pea jump right back. These plants don't root kill in fires, and stem density and seed production increases greatly after burning. The new growth is tender, and we have also found astounding numbers of cottontails feeding in these areas after a burn.

We would like to see more desirable native legumes on these leased areas, particularly partridge pea and lespedeza. Fire retards some of the introduced species that were in the early seed mixtures and allows native plants to come in. We also broadcast seeds on the burns to encourage this growth of native food plants. No site preparation is needed---we just sow them with a hand seeder. Kolb lespedeza and partridge pea are especially effective.

In controlled studies we did on seeding these burns, the seeded plots showed tremendous regrowth compared to nonseeded plots. Bobwhites are highly attracted to these areas. We are now considering aerial seeding following burns so we can cover larger areas.

## Summary

In the TTWW, we do try to look at the broad picture on wildlife utilization of our project land. We manage just as carefully and intensively for nongame as we do game species. Since public hunting use of these lands is allowed, more emphasis sometimes seems to be on the game, but this is not really the case. In fact, we seem to have a fairly good balance of management for all species of wildlife.

As wildlife and resource managers in the Mobile District, we do a balancing act because that is what gets the best results for all species of wildlife on our disposal areas. We will continue to use these disposal areas for maintenance dredging, but we have found that we can accomplish a tremendous amount of wildlife management between dredging cycles. We think we use our project land and disposal sites very effectively to accomplish natural resource objectives.

SESSION II: HABITAT DEVELOPMENT CASE STUDIES

# HABITAT MANAGEMENT FOR INTERIOR LEAST TERNS: PROBLEMS AND OPPORTUNITIES IN INLAND WATERWAYS

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## Introduction

The interior population of the least tern (*Sterna antillarum*) was added to the Federal Endangered Species List in 1985. Concern for the long-term survival of the least tern is primarily habitat related; much of the riverine island and sandbar habitat historically used by interior least terns has been lost or modified by impoundment, channelization, and bank stabilization projects designed to achieve flood control and navigation objectives.

Since 1985, the Missouri Department of Conservation (MDC) has been involved in an interagency least tern research program, funded in part with Federal Aid Funds administered by FWS's Region 3 Office under Section 6 of the Endangered Species Act. This effort, which has included monitoring of Mississippi River least tern colonies in Illinois, Kentucky, Tennessee, and Missouri, has provided the basis for assessing the use and potential long-term availability of least tern nesting habitat in the Lower Mississippi River.

We appreciate the opportunity to share some ideas regarding least tern habitat management that have emerged from the Cooperative Research Program. There is tremendous potential for using dredged material to enhance least tern nesting habitat, but there are other, more immediate management considerations that also must be addressed if the least tern is to survive as a nesting species in the Mississippi River Valley.

This paper provides an overview of least tern management opportunities, including but not limited to beneficial uses of dredged material. Methods to enhance aquatic habitat for the benefit of other fish and wildlife resources are also discussed from the perspective of a State resource management agency.

## Least Tern Habitat Requirements

### Distribution

The breeding range of the interior least tern has been well documented by the American Ornithologists Union (1983) and the US Fish and Wildlife Service (FWS) (1986a). Though historically the birds nested throughout the Missouri and Mississippi River systems, most of the habitat presently utilized

by least terns in the Mississippi River Valley occurs in that portion of the river below the mouth of the Ohio River (Figure 1). Surveys to monitor specific nesting sites and general population levels of least terns in the Lower Mississippi River (FWS 1985 and 1986b, Smith 1987) have illustrated the tremendous importance of that region to the continued survival of the interior least tern. Over 50 percent of the remaining population of these birds occurs in the Lower Mississippi River. No colonies are known to exist on the Mississippi River north of Cape Girardeau, MO (FWS 1986a, Smith 1987).

### Habitat Requirements

The distribution of nesting least terns within a riverine system depends upon several related ecological factors which include: (a) the presence of sand/gravel bars and sand islands; (b) the existence of favorable water levels during the nesting season; and (c) the availability of food, in the form of small fish (Hardy 1957). The primary requirement for nesting is a substrate of loose sand or gravel that will allow the construction of a nest scrape. Optimal colony sites occur on sand islands rather than on bars that are accreted to the shoreline. Island habitat is critical because it affords these ground-nesting birds needed protection from mammalian predators. Island nesting habitat also minimizes the accessibility of colonies to all-terrain vehicles (ATV), which are becoming a major threat to the reproductive success of least terns.

## Concerns

The MDC is extremely concerned about the continuing loss of fish and wildlife habitat in our major rivers. Of particular concern are the effects that existing and proposed civil works structures have on overall aquatic diversity and on long-term availability of least tern nesting habitat in the Lower Mississippi River Valley.

In a channelized river system, quiet productive backwater habitat is often scarce or nonexistent. Standard civil works structures can provide this important habitat component at low river stages (Sandheinrich and Atchison 1986, Beckett and Pennington 1986), but such benefits are usually short-lived. The decreased velocities within dike fields typically cause deposition of sediments and subsequent accretion to the mainland (Burch et al 1984). Of concern to biologists is this shift toward increasingly higher percentages of biologically unproductive main channel at the expense of more productive slack water habitat (Nunnally and Beverly 1986). The classic documented example of this process is the Missouri River where over 100,000 acres of publicly owned riverine aquatic resources were converted to privately owned bottomland. Over 60,000 surface acres of water, fully 50 percent of the original surface area in the lower 500 miles of the Missouri River, were lost between 1879 and 1972, mostly to civil works structures (Funk and Robinson 1974). Similar losses occurred along the Iowa/Nebraska portion of the river (Sandheinrich and Atchison 1986, Hallberg et al. 1979) where drastic reductions in acreage of sandbars and islands have been documented since 1930.

A photographic series (Figure 2) of Indian Cave Bend on the Missouri River in Holt County, Missouri (RM 517), graphically shows the conversion process. In September 1934, the river at that location was in a wide, naturally diverse condition. A year later, pile dikes had been constructed and were already effectively doing their job of trapping sediment. Some 11 years later, the river had been narrowed, and aquatic habitat had been converted to terrestrial habitat. By 1954, the conversion to cropland had begun, and by 1977, the conversion was complete. It isn't difficult to understand the decline of least terns under such circumstances.

Of immediate concern for least tern management is the potential for land accretion to occur in Lower Mississippi River dike fields (Beckett and Pennington 1986). This continued accumulation of dike field sediments, and if allowed to reach the ultimate end of attachment to the shoreline, would eliminate most of the least tern nesting habitat that remains in the Lower Mississippi River. Of 21 sites that have been used by least terns for nesting at one time or another in the Missouri reaches of the Mississippi River since 1985, 11 are associated with dike fields, and 6 others are on point bars that are in various stages of accreting to the shoreline (Smith 1987). Surveys have shown such habitat to be equally important to least terns nesting below the Missouri reaches of the river (Rumancik 1986). Obviously, the loss of existing dike fields and point bars as aquatic habitat would have a devastating impact on the interior least tern population in the Mississippi River Valley.

Whether the dike fields of the Lower Mississippi River will have the same fate as those of the Missouri River is unknown at this time (Beckett and Pennington 1986). Most dike fields of the Lower Mississippi River have been constructed since 1960 (Nunnally and Beverly 1986). While acknowledging that the Missouri River experience with river control cannot be directly extended to the Mississippi River because of fundamental hydrologic and morphologic differences, there is concern that sedimentation induced by dike fields on the Lower Mississippi River will adversely affect riverine habitat (Nunnally and Beverly 1986, Sandheinrich and Atchison 1986) and eventually lead to loss of least tern nesting habitat. Indeed, the processes of dike field terrestrialization are well underway at several least tern nesting sites in the Lower Mississippi River, including a critically important nesting island that is annually posted as a least tern refuge by the MDC.

In addition to preserving riverine aquatic habitat, another important consideration relative to arresting the accretion process is floodway maintenance. The carrying capacity of many rivers has been greatly reduced by channelization, resulting in higher flood stages at lower discharge rates. For example, during the Great Flood of 1903, the Missouri River discharge at Hermann, MO, was 676,000 cfs on June 6, with a gauge reading of 29.5 ft (Figure 3). Channelization was well underway by the flood of 1951 when the recorded discharge of 618,000 cfs yielded a gauge reading of 33.33 ft. On 5 October 1986, the river reached a gauge height of 35.79 ft with a discharge rate of only 547,000 cfs. The capacity of the floodway had been altered to the point that a reduction of 129,000 cfs over 1903 levels still caused a

river stage that was 6.3 ft higher. The same effect was noted for the Mississippi River following the 1973 flood (Belt 1975). We believe that maintaining dike fields as aquatic habitat would help sustain the river's ability to pass floodwaters and reduce the magnitude and duration of flooding.

## Case Studies

Following are four case studies that provide opportunities for enhancing least tern habitat and aquatic habitat diversity through the use of flood control structures and dredged material.

### Modification of Structures

Case 1. During the past decade, the St. Louis CE District has notched or modified 75 structures on the 200 miles of open Mississippi River below St. Louis, MO. The objectives of this effort are twofold: (a) to arrest the accretion process caused by these structures; and (b) to restore a measure of habitat diversity in the channelized river. Although there is still much to learn regarding this effort, studies have shown that both objectives can be achieved (Smith et al. 1982, Grace and Weithman 1983). Additional advantages of using notches as environmental features include: (a) maintenance provisions of existing navigation authority can be used; (b) work can be performed from a floating platform; and (c) no large expenditures are required. Indeed, notches may actually save costs of stone on new construction or repairs (Burch et al 1984). Notched dikes and rootless dikes have tremendous potential for creating and maintaining least tern habitat while at the same time restoring a substantial measure of overall aquatic diversity.

A challenge to expand and apply the concept of achieving channel maintenance objectives while preserving riverine aquatic habitat presently exists in this stretch of river as the long-range goal of the St. Louis CE District engineers is to further constrict the river from its present 1,800-ft width to 1,500 ft. A 300-ft reduction in width over the 200 miles of river represents a surface area of 7,273 acres. If control structures are raised, sloped, and extended in the traditional manner, much of that acreage will accrete and become fast land. Not only would we lose thousands of surface acres of aquatic habitat, but those acres would be taken out of public ownership and become the private property of adjacent landowners. Franco (1967) stated that there is a greater tendency for scouring to occur near the bank end of level dikes than of sloping dikes, which suggests that a level dike profile, perhaps with intermittent notches, may help to reduce or eliminate the accretion of dike field sediments and maintain the dikes as aquatic habitat. We are hopeful that river engineers will rise to this challenge.

Case 2. The Memphis CE District has recently contracted for the construction of a new spur dike at approximately RM 902 in the Lower Mississippi River. The purpose of the proposed dike is to alleviate a serious shoaling problem at a sharp bend in the river. By shifting the channel toward the concave shoreline, it is hoped that future needs for dredging will be reduced. Ironically, the sand island that river engineers want to eliminate at RM 900-901 provides nesting habitat for least terns.

The need for the proposed dike presents the District with an opportunity to achieve a major channel maintenance objective while at the same time enhancing least tern habitat. Following construction of the new dike, deposition of sediment is likely to form a point bar on the Missouri side of the channel. Therefore, our challenge to river engineers is to modify the proposed structure so that a sand island will be formed below the new dike to replace the one that is presently used by nesting terns.

It may well be asked whether the CE is obligated to address this important resource issue. Several seemingly logical arguments, each with an element of truth, have been raised regarding this situation. Some would argue that the loss of this sand island is not a significant threat to least tern survival because the birds respond so well to changing habitat conditions that they would probably just "go someplace else" to nest. It has further been suggested that the CE should not have to assume responsibility for potential loss of this island because least terns in the Lower Mississippi River Valley nest almost exclusively on habitat created incidental to achieving channel maintenance objectives. This implies that the CE may already be doing enough for the least tern in the Lower Mississippi River Valley.

When confronted with such arguments, it is easy to lose sight of the big picture regarding long-term availability of least tern habitat. Dike fields and other habitat that the terns depend upon are now limited to transient replacements for their natural habitat. Nunnally and Beverly (1986) documented the loss of 29 sq miles (18,564 acres) of bar and island habitat in the Memphis CE District in the Lower Mississippi River between 1962 and 1976, most of which occurred within diked reaches.

There is no room for administrative or bureaucratic complacency regarding the remaining limited habitat base of the interior least tern particularly when the long-term picture is clouded by uncertainty as to the eventual fate of that very habitat. Because the ultimate effects of channelization have not yet been determined on the Lower Mississippi River (Nunnally and Beverly 1986, Sandheinrich and Atchison 1986), every site presently used by nesting least terns must be regarded as essential. Indeed, management should be directed toward enhancing existing habitat and creating new sand islands whenever feasible. We can't afford to lose a single least tern nesting site to further river modification without adequate provisions for mitigating the loss. It is the balancing and integration of channel maintenance objectives with opportunities for enhancement of fish and wildlife habitat values that forms the major challenge to agencies now involved in the management of riverine resources (Sandheinrich and Atchison 1986).

We would further emphasize that the provisions of the Endangered Species Act require consultation between the CE and FWS regarding destruction of endangered species habitat. Consequently, a plan should be developed to mitigate any loss of endangered least tern habitat that may result from construction of any new dike.

## Beneficial Uses of Dredged Material

The following cases are presented as examples of proposals and experiments to enhance riverine resource values using dredged material. There are presently no projects that seek to enhance or create least tern habitat in the Lower Mississippi River using dredged material, but the FWS and the St. Louis CE District are exploring possibilities for using dredged material to enhance least tern habitat on the Mississippi River above the mouth of the Ohio River. Some use of dredged material deposits by least terns occurs in the Kentucky reaches of the Ohio River, but those deposits have proven to be ephemeral (Wayne Davis 1987, personal communication). Armoring dredged material containment areas, as described below, may help to ensure the availability of least tern nesting habitat under such circumstances.

Case 3. The St. Louis CE District annually dredges from 3 to 6 MCY of material from the Mississippi River. In recent years, interagency coordination efforts have been directed toward: (a) seeking to eliminate or reduce dredging in those reaches with chronic shoaling problems through the use of control structures; and (b) seeking to find beneficial uses for dredged material.

The CE and the MDC, under authority and funding provided by the WRDA, Section 1103, have jointly developed a project proposal to use dredged material to construct approximately 200 acres of shallow water wetland/backwater habitat in Pool 25. The river reach between approximate RM 249-251 requires frequent dredging to maintain the navigation channel, and wetland/backwater habitat is limited in that area. The goal of the project is to provide benefits to all interests.

The first phase of the proposed project will be to construct the nose of the island using riprap to ensure that the dredged material island does not erode downstream (Figure 4). The location and configuration of the island are critical from the river engineers' perspective. Ideally, the island will serve as a hydraulic control that will greatly reduce, perhaps even eliminate, the need for dredging at that location. St. Louis District engineers intend to prepare and study a model of that river reach before a final decision is made regarding location, size, and island configuration.

Phase II will involve construction of the island using dredged material. A wide track dozer will be used to shape the island profile. We envision the elevation of the island to be near normal pool elevation, with deeper swales and interior sloughs. A horseshoe-shaped island would create productive backwater habitat (Figure 4). Future management activities would include seeding desirable aquatic or moist soil vegetation and, if necessary, removal of invading woody vegetation.

The estimated cost of the project is $250,000. However, this figure is subject to change pending completion of engineering and design plans and receipt of funding. It is anticipated that these costs will be more than offset by reductions in future dredging costs.

Observations and practical applications include:

a. Constraints such as pumping capacity and lack of funding or authority to riprap the upper end of dredged material islands frustrate proposals to find beneficial uses for dredged material.

b. Long-term solutions to chronic dredging problem areas may be achieved through close coordination with resource management agencies.

c. Additional costs should be weighed against reductions in future dredging costs and potential fish and wildlife benefits.

Case 4. Schwanigan Island is located in the Upper Mississippi River Pool 25 at RM 254. During the past several years, in excess of 100,000 cu yd of material has been dredged annually from the navigation channel at that location. Historically, this material has been dumped along the left or right main channel border areas significantly degrading important productive aquatic habitat.

In 1985, 180,155 cu yd of dredged material were placed adjacent to the lower end of the island. A high river stage subsequently spread the material downstream creating a flat 4- to 5-acre shallow water wetland area that was connected to the island. The elevation of the area was at or slightly below normal pool (428 ft msl), and rooted emergent and aquatic vegetation quickly invaded the area. Numerous young-of-the-year fish were later observed in the shallow water, and the area has been used by other wetland dependent species, including great blue herons, waterfowl, and various shorebirds.

Observations and practical applications include the following:

a. Dredged material can be used effectively to create productive, shallow water wetland areas.

b. The lower end of an existing island is an ideal location to create a wetland because the island serves to buffer flow velocities that may erode or move the material downstream.

c. A wide-track dozer would be helpful to initially shape or flatten the island to the desired configuration and elevation.

d. It may be necessary to periodically remove invading woody vegetation (willows, silver maple, cottonwood, etc.) to maintain desirable wetland habitat. Again, a wide-track dozer would be quite useful in accomplishing such management objectives.

Opportunities for using this concept of island creation with dredged material to develop or manage least tern habitat include: (a) the enhancement of existing colony sites; and (b) the creation of new island habitat within the tern's present breeding range and in areas having species restoration potential. The value of dredged material habitat has been demonstrated for a wide range of avian species, including the least tern in coastal areas (Soots and Landin 1978, Parnell et al. 1986).

We recognize that, from the CE perspective, there are constraints for material placement which include time, cost, and equipment limitations. One or more of these constraints often frustrate attempts to place material in the most desirable locations. Indeed, opportunities for beneficially using dredged material within the present breeding range of the least tern in the Lower Mississippi River are essentially nonexistent primarily because of equipment limitations. We are encouraged that the CE is sponsoring workshops such as this one, and we are hopeful that from these sessions will emerge uniform policies and guidelines addressing these constraints and the beneficial use of dredged material.

## Summary and Recommendations

The 1985 Digest of Water Resource Policies states, "Adverse effects on fish and wildlife resources and opportunities for improvement of fish and wildlife shall be examined along with other purposes which might be served by water resource development." To effectively carry out this mandate, biologists and engineers must interact to better understand each other's missions. It is our conviction that such interaction would reduce or eliminate the adversarial posture that so often frustrates attempts to reach effective compromises to benefit all interests.

Could the Missouri River project have been designed to achieve the commercial navigation channel objective without the tremendous loss of our riverine aquatic resources? Can we develop new approaches to channel maintenance objectives that would narrow the Mississippi River channel to the planned 1,500-ft width without a complete loss of over 7,000 surface acres of aquatic habitat? Can control structures be used to create and maintain island habitat? We think so, and this is our challenge to the engineers listening today. We believe that modification of control structures holds tremendous potential for accomplishing both channel maintenance objectives and aquatic ecosystem enhancement. As biologists, we can provide insights into habitat needs, but it is up to you, the engineers, to modify existing designs or to create new ones to meet the intended objectives. We can no longer afford to be satisfied with the old way of doing things; new innovative engineering approaches are needed now to incorporate fish and wildlife values into the river resource management of the future.

As an initial step, we recommend that an interagency working group be established for the Lower Mississippi River to identify and assess problems associated with multipurpose use. This approach has been used successfully on the Upper Mississippi River since 1973 by the GREAT (GREAT I 1980). Such a team, composed of State and Federal agencies with management responsibilities on the river, could work together to develop recommendations for improved multipurpose management of Lower Mississippi River resources, with special emphasis on the least tern.

The key to our proposal is to make everyone a winner. If by creating an island in a problem area we can improve the self-maintaining capabilities of the river channel and reduce the future needs for dredging, then everybody

wins--the diversity of our aquatic ecosystem is not compromised, and the least tern stands to benefit from increased habitat availability.

## Acknowledgments

We appreciate the advice and assistance provided by John W. Robinson, William H. Dieffenbach, James Fisher, and Dawn Drainer during the preparation of this manuscript.

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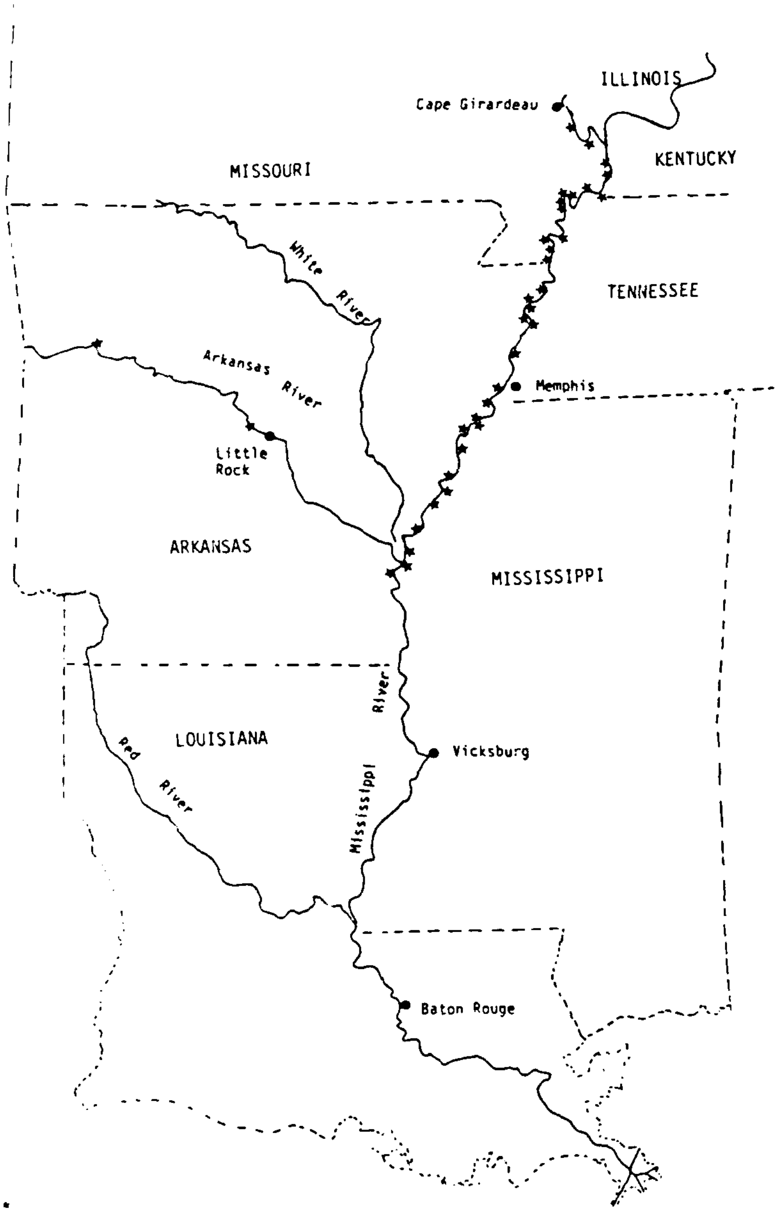


Figure 1. Location of confirmed and suspected interior least tern colony sites in the Lower Mississippi River Valley, June and July 1986 (Adapted from Landin 1985).

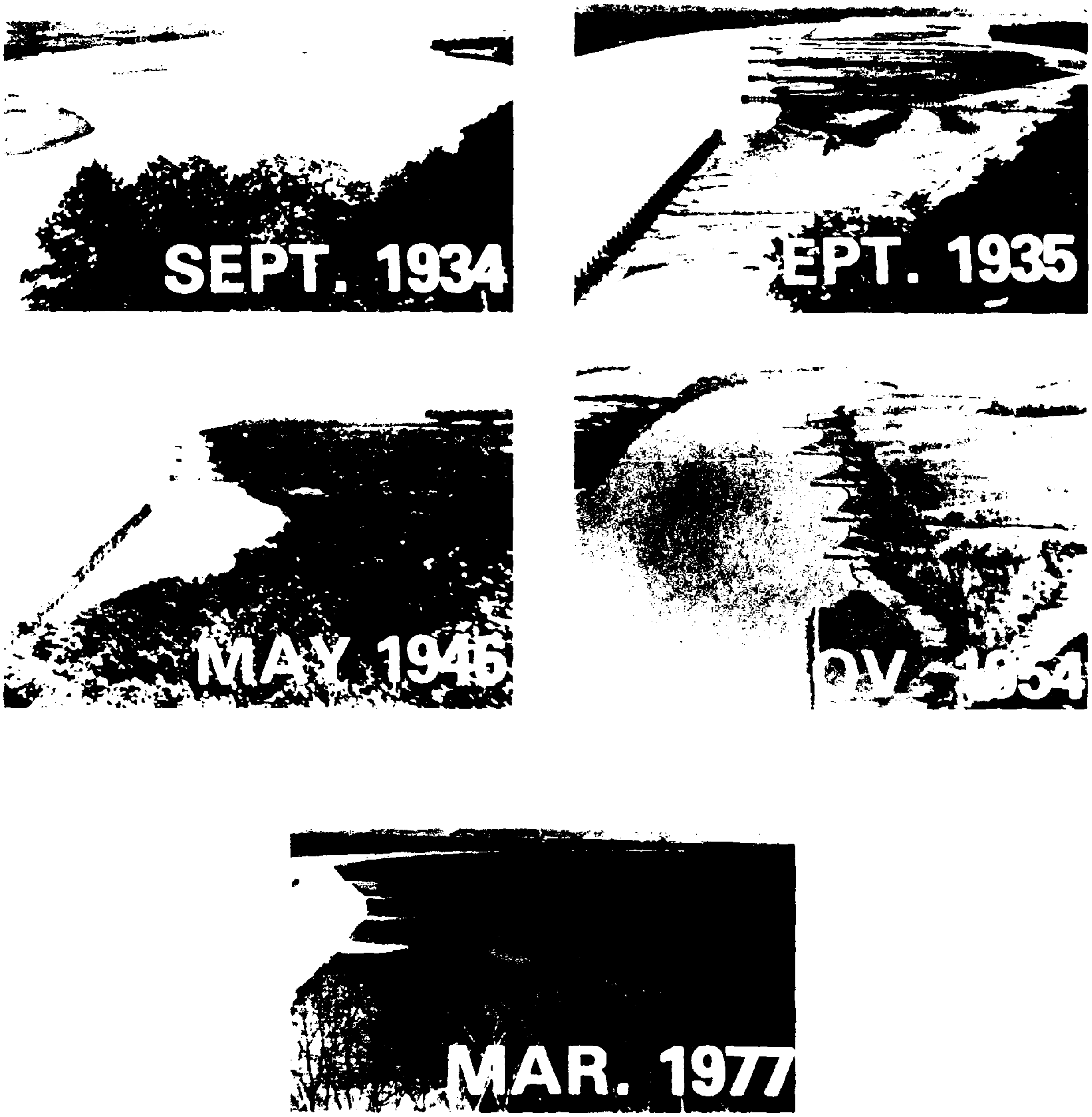


Figure 2. Photographic series at Indian Cave Bend (RM 517, Missouri River) showing the conversion of aquatic habitat to terrestrial habitat within a dike field

# MISSOURI RIVER AT HERMANN

| DATE | DISCHARGE | GAUGE |
|---|---|---|
| 6 JUNE 1903 | 676,000 CFS | 29.50 |
| 19 JULY 1951 | 618,000 CFS | 33.33 |
| 5 OCTOBER 1986 | 547,000 CFS | 35.79 |

Figure 3. Missouri River discharge (cfs) and gauge readings (ft) at Hermann, MO, during floods

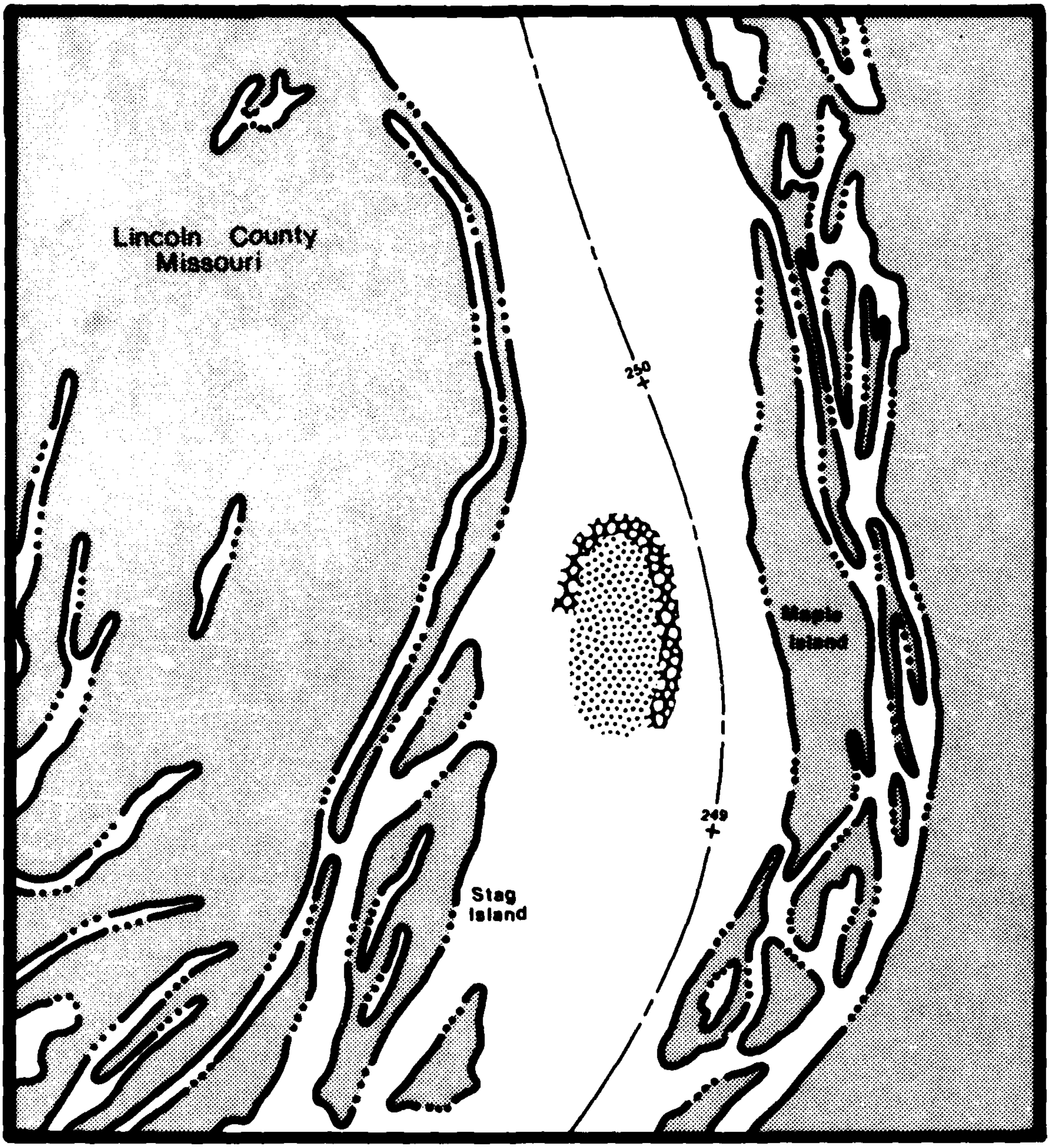


Figure 4. Artist's conception of proposed dredged material island, R M 249-250, Upper Mississippi River (Pool 25).

QUESTION: I hate to burst your bubble, but engineers have to talk to fisheries people as well as biologists.

MR. SMITH: Of course both fisheries and wildlife biologists must be involved. I didn't mean to convey that wildlife was the only consideration, but a multifaceted approach to these rivers is needed. I would like to see GREAT plans set up for the Lower Mississippi River and the Missouri River, and I think everyone involved with the Upper Mississippi River GREAT I, II, and III should be very proud to be part of such an outstanding program that benefits everyone---industry, recreation, fish and wildlife, and the general public. There has to be give and take on both sides.

QUESTION: Isn't sediment accumulating behind the wing dikes?

MR. SMITH: Yes, and that is the long-term problem for least tern habitat management. The bars appear to be accreting to the shoreline which in turn gives access to predators, off-road vehicles, vegetation encroachment, and other problems.

QUESTION: You talked about the dike at RM 902. What will happen if this dike is constructed?

MR. SMITH: If the dike is constructed as designed and planned, we expect a point bar to form that will accrete to the shoreline. It will eventually replace the island that is being used by nesting terns at that location now.

COMMENT FROM AUDIENCE: You need to understand that, first and foremost, dike fields must be constructed to maintain channel location integrity---any other consideration such as nesting terns and their habitat has to be strictly secondary.

MR. SMITH: We are not suggesting that the channel maintenance functions of dikes should be compromised on behalf of the least tern. But, there is a clear need for multiple-use aspects of river management, particularly those relating to fish and wildlife habitat values, to receive a higher level of priority during the planning process. If a dike field can be designed or modified to enhance endangered least tern habitat without adversely affecting channel maintenance, then we believe it should be accomplished.

# ESTABLISHMENT OF A NATIVE MIDWESTERN WETLAND PLANT COMMUNITY THROUGH RELOCATION OF MARSH TOPSOIL

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## Introduction

The quick and effective establishment of permanent wetland vegetation is a critical element of wetland creation and restoration projects. For many of these projects, particularly those that attempt to develop wetlands using dredged material, revegetation is intended to serve secondary purposes such as substrate stabilization, wildlife habitat, shoreline protection, and similar functions. Plant community restoration for purposes of preserving rare floral and faunal elements is not typically a principal goal. These wetland development efforts are, therefore, frequently termed successful if good stands of one or several plant species succeed. Although this may serve project purposes and may, in fact, reflect the contemporary natural species diversity of certain wetland systems, it is inadequate if the goal is to replicate the very high species diversity of many interior wetland plant communities. Yet the reestablishment of these systems is frequently a mitigation goal or simply a resource management goal for regions where natural communities have been or are at risk of being extirpated.

The establishment of diverse inland wetland plant communities such as wet prairie and sedge meadow using seeds and/or nursery stock is beset by numerous problems outside the scope of this paper. However, we report here of our initial success in the relocation of two such areas. The project was part of an overall mitigation plan designed to compensate for wetland impacts resulting from a proposed highway project. Because the impacted sites exhibited regional natural area quality, it was considered appropriate to physically move the substrate in order to ensure the inclusion of as many of the biotic and abiotic components of the sites as possible. The excavated material was hauled to a prepared site and spread around the perimeter of an excavated area where suitable hydrologic conditions were expected to occur. The appearance during the first season's growth of a large percentage of the species known from the donor sites has caused us conditionally to view to the project as successful.

## Project History and Site Descriptions

The project was part of a mitigation plan designed to satisfy CE permit requirements under Section 404 of the Clean Water Act for the proposed North-South Tollway in DuPage County, Illinois (US Army Corps of Engineers 1986). The entire 18-mile roadway corridor is within a portion of the Chicago metropolitan area that is undergoing rapid urban development.

Through the process of identifying and evaluating all wetlands along the roadway corridor, three sites were determined to be of regional natural-area importance. This determination was made through application of a natural area rating method developed specifically for the Chicago region (Swink and Wilhelm 1979).

Briefly, this evaluation method assigns a point value to each of the plant species known to occur in the Chicago region. These values reflect the fidelity of that species to a particular community type or set of environmental parameters. Stated differently, it is a measure of a species' conservativeness under natural conditions or ubiquity under disturbed conditions. The summation and mathematical manipulation of the values of all the species in an area of consideration produces a Natural Area Rating Index (NARI). This index can be used to facilitate comparisons between sites or between a site and the region at large. The NARI is a measure of the degree to which a particular site's flora still reflects diverse, presettlement conditions.

The three wetland sites identified as being important from a natural area perspective are known as Churchill Prairie, Armitage Road wetland, and 75th Street wetland. Churchill Prairie is a 35-acre mesic and wet prairie remnant owned by the Forest Preserve District of DuPage County. The wetland portion of this site is a 17.3-acre seasonally wet prairie. The Armitage Road and 75th Street wetlands are 3.1 and 5.7 acres in size, respectively, and consist of seasonally saturated to seasonally inundated sedge meadow and shallow marsh. Topographically, all three sites are situated in depressions or drainageways that are typical features of the swell and swale terrain of recently glaciated portions of Illinois. These types of prairie wetlands were historically of very high species diversity. These three remnant wetlands, although only 26 acres in aggregate and nearly surrounded by roads and other urban development, contained over 300 species of vascular plants including two state-endangered species. Less than 0.05 percent of the land in the 22-county Chicago region exhibits similar species richness, so complete has been the extirpation of the native flora (Swink and Wilhelm 1979). Therefore, these sites are extremely rare and essentially irreplaceable.

For most of the species known from these sites, there are no local nursery stock or established propagation methods that would permit the practical reestablishment of these communities with their full complement of species. Because of their rarity, however, it was decided that a salvage operation was warranted as part of the total wetland mitigation plan as long as there was reasonable expectation that the salvaged material could be used to redevelop at least a facsimile of the original sites. The decision to excavate and relocate the topsoil rested on our belief that: (a) with proper handling, the seed bank, root stock, rhizomes, and the occasional whole plant

that remained intact would constitute excellent propagative material; (b) the high concentration of these propagules would lead to a dense stand within a short time which would not be overwhelmed by aggressive weedy species; and (c) excavation of all the substrate within a major portion of the root zone would ensure the inclusion of not only plant propagules but also microbial and mycorrhizal root symbionts, larval forms of plant pollinators, and any other organic or inorganic constituents that may be necessary for the maintenance of the system.

## Methods

Topsoil from Churchill Prairie and Armitage Road was moved about 4 miles to a site under Forest Preserve ownership known as Campbell's Slough. The 75th Street site was relocated to another Forest Preserve site but was handled as a separate operation. Because we have not as yet been able to evaluate its success, the remainder of this paper focuses on the Campbell's Slough project.

The site selected within Campbell's Slough originally had been a degraded, depressional wetland area and adjoining upland old field that the Forest Preserve had recently excavated and bermed in order to convert it into a stormwater management pond. It receives runoff from adjacent residental areas and an expressway and has a total watershed area of approximately 130 acres. It discharges through a water control structure which empties into adjacent Salt Creek. The 5-acre basin has a maximum depth of 14 ft and was constructed with a flat shelf which varies between 10 and 30 ft in width around its perimeter for the establishment of the wetland areas. No revegetation of any kind had been done prior to the decision to use it for the relocation of the wetland topsoil.

The establishment of proper hydrology was considered to be of critical importance to the successful establishment of the relocated material. The water regimes best typifying the wet prairie, sedge meadow, and shallow marsh communities to be moved ranged from seasonal to nearly year-round root-zone saturation with some areas experiencing seasonal shallow inundation. The outfall structure in the pond was set at an elevation that would create a normal pool about 9 in. above the average shelf elevation. After the placement of 12 in. of topsoil on the shelf and allowance for settling, the soil would be saturated to the surface at normal pool and would probably remain saturated even during the summer months. Because of some variation in shelf elevation and the thickness of the topsoil, a variety of hydrologic conditions ranging from permanent inundation to temporary flooding has been created to which we feel the plants will sort out in accordance with their preference.

Other major considerations were the proper timing of the work and the proper handling of the material to minimize the opportunity for desiccation or chemical changes to occur. We decided to schedule the work during a season of plant dormancy and low temperatures and also to avoid even temporary stockpiling of the material.

Approximately 1.5 acres of Churchill Prairie and one acre of Armitage Road topsoil were excavated in February 1987. Prior to excavation, the material to be relocated was staked, and temporary haul roads were constructed at all three sites. Relatively dry conditions at Churchill Prairie permitted the use of a front-end loader for the excavation work. The topsoil was removed to a depth of approximately 12 in., loaded directly onto trucks, and hauled to Campbell's Slough.

Standing water and ice at Armitage Road required the use of a modified grade-all with an extended boom for excavating the substrate. Several short stone ramps constructed into the wetland enabled the operator to reach the entire area to be excavated. Because much of the work was conducted under 1 or 2 ft of standing water, a person in chest-waders periodically measured and confirmed that the proper 12-in. excavation depth was being achieved. This material was also hauled directly to Campbell's Slough.

All of the material from both donor sites was deposited near the edge of the prepared area at Campbell's Slough with no attempt made to keep the material from each site separate. Bulldozers pushed this material to the water's edge. Final placement and grading of the material required the use of two grade-alls, one working at the water's edge and the second operating from mats on the submerged shelf. The first grade-all placed the material within reach of the second, which then spread and graded the material across the shelf. By repeatedly relocating the mats in front of itself, the grade-all was able to "walk" its way around the entire pond shelf and work in areas that were inundated with up to 2 ft of water. The material was graded to a thickness of about 12 in.

The entire operation, including excavation of both donor sites, material hauling, and material spreading at Campbell's Slough, occurred over a 3-week period and required the use of three modified grade-alls, one large front-end loader, one small bulldozer, and several dump trucks for hauling. Approximately 3 acres of wetland were relocated at a total cost to the project sponsor of $180,000. This cost does not include the cost of site preparation at Campbell's Slough, which was conducted by the Forest Preserve as part of a stormwater management project.

## Results

New growth of plant materials in the relocated topsoil was first observed in April 1987. During the early portion of the growing season, the large chunks of sod from Churchill Prairie that had survived the move intact showed the most vigorous growth, but by midsummer the entire shelf was nearly uniformly green with root shoots, seedlings, and aquatics.

Prior to excavation of the topsoil, plant species were inventoried in those areas to be excavated at both Churchill Prairie and Armitage Road. A total of 183 native species were identified. The first plant inventory conducted in the new wetland area at Campbell's Slough was done on May 4 when 38 native plant taxa were identified. By August 4, a total of 167 native species had been identified. Among these were 120 (65 percent) of the

183 species originally identified at the Churchill and Armitage excavation sites.

A breakdown (Table 1) of the 167 species identified at Campbell's Slough is as follows: (a) 71.9 percent (120 species) were known from either Churchill Prairie or Armitage Road within the areas excavated; (b) 1.8 percent (3 species) were taxa known from Churchill Prairie but not from the area excavated; (c) 22.7 percent (38 species) had been seen at the Campbell's Slough site prior to construction of the retention facility; and (d) 3.6 percent (6 species) were not known from any of the sites.

Wetland vegetation has become well established during the first growing season at Campbell's Slough. Over 70 percent of the material moved has vegetative cover. Dominant species include prairie cordgrass (*Spartina pectinata*), the sedges *Carex stricta* and *C. lacustris*, and various spikerushes (*Eleocharis* spp.), all of which are good fuel matrix species and will serve to carry a fire during prescribed burns. Future monitoring of the vegetation will include general inventories to document the appearance of additional species as well as the establishment of permanent transects to conduct quantitative sampling. Management will consist of prescribed burns and water level manipulations.

## Discussion

Based on our observations after one growing season, it appears that utilizing topsoil from natural wetlands is a viable method for quickly revegetating newly created wetlands, preserving and propagating rare elements that otherwise might be lost, and retaining high species diversity. We emphasize here that this project was a final attempt to salvage some unique wetland elements that were to be unavoidably impacted---we have not created a "natural area" in the strict sense of the term. We, therefore, caution against viewing the availability of this technique as lessening the need to rigorously examine avoidance as a project alternative when irreplaceable wetland communities would be impacted.

We view our success conditionally because our evaluation spans only the first growing season. The initial appearance of many of these species may have resulted from vigorous root stock or seeds that found initial germination conditions favorable. It is not known if conditions are favorable for their long-term survival or reproduction. We are confident that the less conservative species will persist and provide permanent vegetative cover but are less sure about the persistence---or even the initial appearance---of the rare and sensitive species, particularly those that may require specific insect pollinators or mycorrhizal fungi that may not have transferred with the material.

Even if the goal of revegetation is not to preserve rare species, soil relocation may be an effective method of utilizing local seed banks, rhizomes, and other plant propagules to establish vegetation quickly on wetland mitigation sites. It is particularly appropriate for true wetland creation attempts at sites where no wetland existed previously and there is no existing seed

bank or even suitable substrate. It may have application to a variety of wetland development projects such as boat channel excavation or marina construction where the surface material could be separated and used elsewhere for revegetation.

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COMMENT: This technique has been used in Florida in phosphate mining both in wetland and in upland sites. Florida has saved many acres of wetlands by moving them. They call it the "mulching process."

MS. ELSTON: I know that the technique has been used in other areas, but this is the first time I have ever heard of it being used in our region in freshwater wetlands with these particular plant communities. It has not been tried in the Great Lakes region before.

Table 1

Species Identified on Relocated Material at Campbell's Slough,*

4 August 1987

| SPECIES | ChPr | Arm | Camp | Unk |
|---|---|---|---|---|
| ACALYPHA RHOMBOIDEA | X | X | | |
| ACER NEGUNDO | X | X | | |
| ACER SACCHARINUM | X | X | | |
| ACNIDA ALTISSIMA | | | X | |
| AGRIMONIA GRYPOSEPALA | X | X | | |
| ALISMA SUBCORDATUM | | | X | |
| ALISMA TRIVIALE | X | X | | |
| ALLIUM CANADENSE | X | | | |
| AMBROSIA ARTEMISIIFOLIA ELAT. | X | X | | |
| AMBROSIA TRIFIDA | X | | | |
| AMMANIA COCCINEA | | | X | |
| ANDROPOGON GERARDI | X | X | | |
| APIOS AMERICANA | X | | | |
| APOCYNUM SIBIRICUM | X | X | | |
| ASCLEPIAS INCARNATA | X | X | | |
| ASCLEPIAS SYRIACA | X | | | |
| ASTER ERICOIDES | X | | | |
| ASTER NOVAE-ANGLIAE | X | X | | |
| ASTER PILOSUS | X | | | |
| ASTER SIMPLEX | X | X | | |
| BIDENS CERNUA | | | X | |
| BIDENS COMOSA | X | X | | |
| BIDENS FRONDOSA | X | X | | |
| BIDENS VULGATA | | | X | |
| CALAMAGROSTIS CANADENSIS | X | X | | |
| CALLITRICHE HETEROPHYLLA | | | | X |
| CARDAMINE BULBOSA | X | X | | |
| CAREX ATHERODES | X | X | | |
| CAREX BREVIOR | X | | | |
| CAREX LACUSTRIS | X | X | | |
| CAREX LANUGINOSA | X | X | | |
| CAREX STRICTA | X | X | | |
| CAREX TETANICA | X | X | | |
| CIRSIUM DISCOLOR | X | | | |
| CONOBEA MULTIFIDA | | | X | |
| CONVOLVULUS SEPIUM | X | X | | |
| COREOPSIS TRIPTERIS | X | | | |
| CORNUS RACEMOSA | X | X | | |
| CUSCUTA CORYLI | | | X | |
| CUSCUTA GLOMERATA | | | | X |
| CUSCUTA GRONOVII | | | X | |
| CYPERUS ERYTHRORIZOS | | | X | |
| CYPERUS FERRUGINESCENS | | | X | |
| DESMODIUM CANADENSE | X | | | |
| ECHINOCHLOA CRUSGALLI | X | | | |
| ELEOCHARIS ACICULARIS | X | X | | |
| ELEOCHARIS SMALLII | X | X | | |
| ELLISIA NYCTELEA | | | | X |
| ELYMUS VIRGINICUS | X | | | |
| EQUISETUM ARVENSE | X | | | |
| ERAGROSTIS HYPNOIDES | | | X | |
| ERECHTITES HIERACIFOLIA | X | X | | |
| ERIGERON ANNUUS | X | | | |
| ERIGERON CANADENSIS | | | X | |
| ERIGERON PHILADELPHICUS | X | X | | |
| EUPATORIUM ALTISSIMUM | X | | | |
| EUPATORIUM MACULATUM | X | X | | |
| EUPATORIUM SEROTINUM | | | X | |
| FRAGARIA VIRGINIANA | X | X | | |
| FRASINUS PENNSYLVANICA | | | X | |
| FRAXINUS PENNSYLVANICA SUB. | X | X | | |
| GALIUM OBTUSUM | X | X | | |
| GENTIANA ANDREWSII | X | | | |
| GERARDIA TENUIFOLIA | | | X | |
| GEUM LACINIATUM TRICHOCARPUM | X | X | | |
| GLYCERIA SEPTENTRIONALIS | X | X | | |
| GLYCERIA STRIATA | X | | | |
| HACKELIA VIRGINIANA | | | | X |
| HELENIUM AUTUMNALE | X | | | |
| HELIANTHUS GROSSESERRATUS | X | X | | |
| HYPOXIS HIRSUTA | X | X | | |
| IRIS VIRGINICA SHREVEI | X | X | | |
| JUNCUS DUDLEYI | X | | | |
| JUNCUS NODOSUS | | | X | |
| JUNCUS TENUIS | X | | | |
| JUNCUS TORREYI | | | X | |
| LATHYRUS PALUSTRIS MYRT. | X | | | |
| LATHYRUS PALUSTRIS | X | | | |
| LEERSIA ORYZOIDES | X | | | |
| LEMNA MINOR | | | X | |
| LILIUM MICHIGANENSE | X | X | | |
| LINDERNIA ANAGALLIDEA | | | X | |
| LINDERNIA DUBIA | | | X | |
| LUDWIGIA PALUSTRIS AMERICANA | | | X | |
| LUDWIGIA POLYCARPA | X | X | | |
| LYCOPUS AMERICANUS | X | X | | |
| LYCOPUS UNIFLORUS | X | X | | |
| LYCOPUS VIRGINICUS | X | | | |
| LYSIMACHIA QUADRIFLORA | X | | | |
| LYSIMACHIA THYRSIFLORA | | | | X |
| LYTHRUM ALATUM | X | X | | |
| MENTHA ARVENSIS VILLOSA | X | | | |
| MUHLENBERGIA FRONDOSA | | | X | |
| MUHLENBERGIA MEXICANA | X | | | |
| OENOTHERA BIENNIS | X | X | | |
| OXALIS EUROPEA | | | X | |
| OXALIS STRICTA | X | X | | |
| OXYPOLIS RIGIDIOR | X | | | |
| PANICUM CAPILLARE | X | | | |
| PANICUM DICHOTOMIFLORUM | X | | | |
| PANICUM VIRGATUM | X | | | |
| PARTHENOCISSUS QUINQUEFOLIA | X | X | | |
| PEDICULARIS LANCEOLATA | X | | | |
| PENTHORUM SEDOIDES | | | X | |
| PHALARIS ARUNDINACEA | X | X | | |
| PHLOX GLABERRIMA INTERIOR | X | | | |
| PHYSALIS HETEROPHYLLA | X | | | |
| PHYSALIS SUBGLABRATA | | | X | |
| PLANTAGO RUGELII | | | X | |
| POLYGONUM AMPHIBIUM STIP. | X | X | | |
| POLYGONUM COCCINEUM | X | | | |
| POLYGONUM ERECTUM | X | | | |
| POLYGONUM HYDROPIPEROIDES | | | X | |
| POLYGONUM LAPATHIFOLIUM | X | | | |
| POLYGONUM PENSYLVANICUM LAEV. | X | | | |
| POLYGONUM PUNCTATUM | | | X | |
| POLYGONUM SCANDENS | X | | | |
| POPULUS DELTOIDES | X | X | | |
| POTAMOGETON FOLIOSUS | | | X | |
| POTENTILLA NORVEGICA | X | | | |
| POTENTILLA SIMPLEX | X | | | |
| PROSERPINACA PALUSTRIS CREBRA | X | X | | |
| PYCNANTHEMUM VIRGINIANUM | X | X | | |
| RANUNCULUS FLABELLARIS | X | X | | |
| RANUNCULUS SCELERATUS | | | X | |
| RHUS GLABRA | X | | | |
| RORIPPA ISLANDICA FERNALDIANA | X | | | |
| ROSA CAROLINA | X | | | |
| ROSA SETIGERA | X | | | |
| RUBUS ALLEGHENIENSIS | X | | | |
| RUBUS OCCIDENTALIS | X | | | |
| RUDBECKIA HIRTA | X | | | |
| SAGITTARIA GRAMINEA | X | X | | |
| SALIX AMYGDALOIDES | | | X | |
| SCIRPUS ACUTUS | X | X | | |
| SCIRPUS FLUVIATILIS | | | X | |
| SCIRPUS VALIDUS CREBER | | | X | |
| SCUTELLARIA EPILOBIIFOLIA | X | | | |
| SCUTELLARIA LATERIFLORA | X | X | | |
| SOLIDAGO ALTISSIMA | X | X | | |
| SOLIDAGO GIGANTEA | X | X | | |
| SOLIDAGO GRAMINIFOLIA MEDIA | X | X | | |
| SOLIDAGO GRAMINIFOLIA NUTT. | X | X | | |
| SOLIDAGO MISSOURIENSIS FAC. | X | | | |
| SPARTINA PECTINATA | X | X | | |
| SPHENOPHOLIS INTERMEDIA | X | X | | |
| SPOROBOLUS NEGLECTUS | | | X | |
| STACHYS PALUSTRIS HOMOTRICHA | X | | | |
| STACHYS TENUIFOLIA HISPIDA | X | | | |
| TEUCRIUM CANADENSE | X | | | |
| THALICTRUM DASYCARPUM | X | | | |
| THALICTRUM DASYCARPUX HYPO. | X | | | |
| TRADESCANTIA OHIENSIS | X | | | |
| TYPHA ANGUSTIFOLIA | | | X | |
| TYPHA LATIFOLIA | X | X | | |
| ULMUS AMERICANA | X | X | | |
| VERBENA HASTATA | X | X | | |
| VERBENA URTICIFOLIA | X | | | |
| VERONICA PEREGRINA | | | X | |
| VERONICASTRUM VIRGINICUM | X | | | |
| VIOLA AMERICANA | X | | | |
| VIOLA CUCULLATA | X | | | |
| VIOLA PAPILIONACEA | X | X | | |
| VIOLA SEPTENTRIONALIS | | | | X |
| VITIS RIPARIA | X | X | | |

* ChPr = known from Churchill Prairie; Arm = known from Armitage Road site; Camp = known from Campbells Slough site; Unk = unknown from any site.

## SESSION III: INNOVATIVE BENEFICIAL USES AND CONCEPTS

### OPENING REMARKS

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I want to talk to you about the three P's: Preservation, Protection, and Productivity. These three words are three of the most misused and misunderstood in the natural resources lexicon. I will not cite dictionary meanings. Instead, I will discuss the implications of these three terms to the natural resource arena.

There is an entire set of characteristics surrounding these words that needs to be elucidated. However, before I begin, I want to relate a short scenario. Recently, I attended a seminar where the speaker at one point discussed race relations with predictable behaviors. He gave an office scenario where the white production-oriented boss is hard at work at his desk in the early morning when his black secretary arrives for work. Cheerfully, she says, "Good morning!" and he gruffly replies, "Ms. James, I can't find the Jenkins file anywhere!" You can imagine in what direction the rest of the day went. It was all downhill from there.

The speaker went on to explain a little psychology. He said that European tradition is generally "object oriented," seeking goals and rewards through inanimate objects such as gold and precious metals, fancy houses, fast cars, high paying jobs, and status. Oriental cultures tend to be group-oriented and tend to do activities that work toward improving the entire culture not just the individual. For example, when I was in Japan a decade ago, I noticed individuals on the streets wearing surgical masks, and when I inquired why the masks, I was told that they were ill and perhaps had colds. While we don't wear masks in public in our society, I could see in the Japanese how the individual behaved on behalf of the society.

The last category that the speaker explained was that of the African society where the emphasis in not on objects or the society but on interpersonal relationships. Thus, in the scenario just presented, the boss is working from one set of standards, partly because his societal norms are oriented toward accomplishing assignments, while his secretary is offended because she reacted from an entirely different response-base oriented toward interpersonal relationships.

This brings us to the three P's and perhaps why some of us are oriented toward preservation and some toward production. The term "preservation" is associated with "preservationists" who are often perceived as obstructionists to particular projects. They are looked upon as persons unwilling to bend even when long-term results are to be achieved for the society as a whole. Some say they stand in the way of progress.

The image we have of the production-oriented individuals is "full steam ahead" and "production at any cost." "Let's get on with the job!" and "Get it done!" might be their mottos. They are perceived as being narrow-minded and refusing to consider broader goals because they might not be "cost-effective." This hard-hat image can permeate every aspect of their lives, even to running their home as if the home were an extension of work, needing commands and expeditious handling to make sure everything runs smoothly.

In the middle ground, protection affords an opportunity that has the best parts of preservation while at the same time keeping the desired results from productivity. The Water Pollution Control Act of 1972 has the following introductory line:

> "It is the national goal that wherever attainable, an interim goal of water quality which provides for the <u>protection</u> and propagation of fish, shellfish, and wildlife...be achieved..."

Notice the emphasis on the word "protection" and its relation to natural resources. It doesn't say "for the preservation of the species" or "for increased species productivity." "Preservation" is used in the act at other points, but it is often associated with preventing or eliminating pollution not associated with natural resources.

For my agency, the Soil Conservation Service (SCS), reducing the loss of topsoil is a prime objective, not only to maintain agricultural productivity but to keep topsoil on the land and minimize offsite damages such as silting of rivers and reservoirs. There is inherent conflict between <u>preserving</u> soil and maintaining <u>productivity</u>. If we could prevent all the topsoil from leaving the land, it might be possible to have productivity beyond our wildest dreams. However, we live in a less than perfect world where erosion and soil loss are the facts of life. Therefore, our job becomes one of protection. We must implement conservation practices to protect the soil---keep it where it is and reduce offsite effects. This in turn makes the CE's job easier because there is less siltation of the Nation's rivers and streams. However, just as there will always be soil loss and a need to protect soil resources, there will always be a need to keep our navigation channels clear because we can never entirely stop the soil erosion process.

In our everyday jobs concerning natural resources, we often find ourselves struggling over decisions involving conflicting goals where individuals are tightly wedded to either the preservation or the productivity ends of the spectrum. As the arguments become more and more strident, we wonder how we are ever going to reach a solution. If we decide in favor of preservationists, we may lose an important opportunity to increase the productivity of a region. If we decide in favor of production, we may lose valuable habitat or species that add immeasurably to the quality of life of the region. What do we do?

While there are situations where solely preservation or production are the logical and only choices to make, there are far more occasions where the "protection" option offers the best and most reasonable approach. The protection approach can incorporate the best components of preservation and productivity. We, as managers of the natural resources of this Nation, must

be careful listeners to hear what people in natural resource controversies are saying. We must make the crucial decisions to protect all aspects of the environment. If we do that, we can find options and opportunities that no one else has seen. We can forge solutions where others have failed, and in doing so, we perform an incalculable service to our Nation and its natural resources.

SESSION III: INNOVATIVE BENEFICIAL USES AND CONCEPTS

# RECLAMATION OF PYRITIC MINE SPOIL USING CONTAMINATED DREDGED MATERIAL

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## Introduction

Strip mining has played a key role in the production of coal used to produce energy. About 810,000 ha of land have been strip mined for coal in the US since 1965. In strip mining for coal, the land is stripped of vegetation, a deep cut is made into the basin or hillside, and the waste overburden is piled or cast down the slope. The unsightly areas created by strip mining have resulted in public pressure for State and Federal laws directing mine owners to submit a reclamation plan when applying for a mine license and/or permit. There remain many abandoned strip mines, however, that are sources of acid mine runoff and erosion. The desired result of reclamation on strip mine spoils is the establishment of vegetation for the control of acid runoff and soil erosion.

The Ottawa, IL, area strip mine reclamation project was initiated in 1978 as a Productive Uses Project of the WES Dredged Material Research Program. It was designed to demonstrate a potential productive use of dredged material; i.e., the large-scale reclamation of pyritic mine spoil or overburden resulting from area strip-mining activities. This productive use of dredged material may be a viable future disposal alternative. This area strip mine reclamation project described herein was created to demonstrate the feasibility of using a cover of dewatered dredged material to reclaim surface mine spoil deposits.

The initial objective of the reclamation effort was the abatement of erosion and acid drainage from exposed pyritic overburdens. This overburden contains excessive amounts of iron pyrite which, when oxidized and wetted, runs profusely off steep-side spoil ridges and produces water high in sulfuric acid. The slow rates at which these spoil areas revegetate and their barren extensiveness foreshadow endless decades of acid runoff if efforts are not made to ameliorate their condition.

In this demonstration, the topography of the spoil ridges was recontoured, and dredged material was used as a substrate for vegetational

development. Placement of the dredged material over the pyritic mine spoil buffered both the acid runoff and limited the infiltration of water as it allowed the establishment of a dense growth of perennial grasses. A control area not treated with dredged material, though leveled and seeded similarly, remained essentially barren.

During the study, certain physiochemical parameters of the test plots within the demonstration project were monitored as were changes in the colonial ecosystem as it became established. The dredged material used in this demonstration project contained low levels of PCBs, PAHs, and toxic heavy metal contaminants, so bioassay and biomonitoring techniques were applied to assess the degree to which contaminants were available and mobile, not only in the initial stages of revegetation but also as the vegetation developed and the dredged material aged.

## Methods and Materials

The construction of the demonstration site has been described in detail by Perrier et al. (1980) and Harrison and van Luik (1980) in WES technical reports. The following is a synopsis of those reports and a description of methodologies used to monitor floristic development and contaminant mobility.

### Construction

The demonstration site was created amid parallel ridges of unvegetated pyritic overburden left after mining stopped in the early 1930's. These eroding ridges of mine spoil were leveled to form a gently sloping plateau (Figure 1). Three treatment plots and one control plot were constructed.

The treated plots received about 0.9-m thick cover of dewatered dredged material obtained from the Alsip disposal facility of the Metropolitan Sanitary District of Chicago. The 24- by 55-m plots are isolated from each other and from the surrounding mine spoil by 0.6 m high beveled containment dikes (Figure 2). The dikes' integrity is maintained by an inert waterproof shroud. Each plot was designed to effect a diagonal slope of about 0.5 percent, the lowest portion of which was designed to drain water volumes which exceeded field substrate capacity through a Parshall flume. In recent years, differential settling of the dredged material has compromised the original slope contours so that there are low areas where shallow standing water accumulates.

The control plot (Plot 1), was constructed of leveled untreated mine spoil. Plot 2, located just south of Plot 1, was constructed of dredged material overlying untreated mine spoil. In Plot 3, about 1.5 metric tons of crushed agricultural limestone were incorporated into the top 15 cm of mine spoil before dredged material was applied. Plot 4 was treated similarly to Plot 3, except that about 2.5 metric tons of limestone were applied.

### Soil Water and Runoff Water Sampling

Surface water was monitored for 1 year and soil water was monitored for 2 years. Soil water monitoring was accomplished by means of pressure-vacuum

soil water samplers. These were installed in duplicate 0.6-m deep in the control plot and at three depths (0.6, 0.9, and 1.5 m) and two locations (25 and 35 m) in each of the treated plots. Parshall flumes constructed of fiberglass reinforced plastic were used to gauge runoff. The flumes were placed in the lowest southwest corner of each plot, and runoff was collected during selected storm events.

Standard procedures for laboratory analysis of water samples were followed by Harrison and van Luik (1980) and summarized here. Each sample collected was drawn into an acid-washed container and placed immediately under refrigeration at 4° C. Water pH was determined within 2 hr of sampling. Following pH determination, samples were divided and preservatives added according to the methods applied. All samples, both with and without preservatives added, were transported to the laboratory in refrigerated chests. Water samples without preservatives added were held for determination of acidity, chloride, and sulfate while water samples with preservatives added were analyzed for heavy metals and nutrient levels.

## Vegetation

After construction in 1978, all four plots were seeded with five species of perennial grasses and one legume (Table 1). Rates of application of pure live seed varied between 17 and 22 kg/ha with a total seed application of 112 kg/ha/plot. After seeding, wheat straw mulch was placed on each plot at a rate of 4.5 metric tons/ha. The mulch was sprayed with an asphalt emulsion to form a binder.

In July of the same year, a survey of the vegetation was conducted to record initial flushes in annual and biennial development (Perrier et al. 1980). In 1979, another survey noted a shift toward the establishment of the seeded perennials. A regularly scheduled vascular plant survey was begun in 1980 and continued each spring through 1985. In 1982, summer and fall surveys were begun as well.

The survey goal was to gather only such data as necessary to describe in general terms the species composition of the plots so that notable changes in composition over time might be recorded. It was decided that the simplest approach was to make estimates of the percent phytomass (standing crop) of the individual plant species within each plot. The estimates were made in increments of 5 percent inasmuch as finer increments could not meaningfully be discerned. Scattered individuals or plants with negligible phytomass were recorded as present only in trace amounts (ranging from a single individual to hundreds) but were always perceived as comprising less than 3 percent of the phytomass. Estimates were made by the same recorder in order to maintain continuity throughout the survey.

In an effort to simplify the estimates, as well as to make them more accurate, each demonstration reclamation plot was divided into five subplots (Figure 2). Estimates were made on the plants in each subplot relative only to other plants in that same subplot. For example, a plant might have been perceived to comprise 15 percent of the phytomass in one subplot and then been undetected altogether in one or more of the remaining subplots. Phytomass estimates for each plant species in the five subplots were averaged so that

their mean values are expressed in terms of their importance relative to all other plants in the plot as a whole on a scale of 1 to 100 (Table 2).

For the comparison of species composition changes from year to year, coefficients of similarity were calculated using the standard relationship

$$2C/A + B \tag{1}$$

where C = the number of species in common, A represents the number of species in one plot, and B represents the number of species in the compared plot. Botanical nomenclature, species concepts, and common names are those employed by Swink and Wilhelm (1979).

<u>Contaminant Mobility</u>

Initial chemical analysis of the dredged material used in the demonstration project indicated the presence of some toxic heavy metals. Therefore, a decision was made to follow the contaminant mobility within the developing ecosystem. Studies utilizing bioassay and biomonitoring techniques were conducted to evaluate toxic heavy metal mobility and the possible presence of organic contaminants such as PCBs and PAHs.

Studies begun in 1979 were designed to address the potential heavy metal uptake by dominant species in the developing, successional ecosystem. Samples of Kentucky 31 tall fescue and Lincoln smooth brome were collected at the field demonstration site. The site plots were designated 1-4 and subdivided into subplots a-e (Figure 2). In each subplot, the most abundant smooth brome and fescue stands were identified and collected. Each sample consisted of total biomass, usually either brome or fescue, that could be encompassed by a 28.7-by 28.7-cm squared carpenter's ruler. The plants were clipped within 5 cm of the soil, and each sample was placed with a label inside a plastic bag, sealed, and placed in a cooler of ice for shipment to WES. Each plant sample was photographed prior to collection. Voucher specimens of all plant species were collected for reference and inclusion in the WES research herbarium.

At WES, extraneous plants were separated from the samples by comparison to herbarium material. Plant material was washed with distilled water, oven dried at 70° C, ground into a coarse powder, digested with nitric acid, and analyzed for arsenic, cadmium, chromium, copper, lead, nickel, zinc, and mercury (Simmers et al. 1980).

Concurrent with the native plant biomonitoring effort, bioassay utilizing yellow nutsedge was directly applied at the field site. This test (Folsom et al. 1981) has been used to describe potential plant uptake of heavy metals from sediments and soils. The 7.6-l inner bucket of the double bucket apparatus (Figure 3) was embedded at the site in each plot. The bucket was filled with plot dredged material, planted with nutsedge which grew for 45 days, then was harvested and analyzed. Results of the field bioassay were compared to colonizing plant data and to the nutsedge data base developed from collections in naturally occurring areas in the Great Lakes region (Simmers et al. 1980).

Plant studies were augmented by the application of an earthworm bioassay (Simmers et al. 1985). This study was designed to aid in determining the major routes of contaminant mobility. The earthworm was used as an indicator of bioavailability of metals in the leaf litter, the surface layer of dredged material (30 cm), and the deep layer of dredged material nearest the mine spoil (100 cm). These data further clarify the contaminant mobility aspects of the reclamation technique in relation to management of large-scale disposals.

Earthworms were obtained from WES cultures and randomized into subsamples of about 150 worms (20 g wet weight) and placed in replicated composite 7.6-1 dredged material samples from 30- and 100-cm depths, as well as in a leaf-litter control. Exposure of 28 days in a controlled growth-chamber at 15° C with low light conditions occurred prior to recovery and analysis. The lower 3-5 cm of test containers were kept saturated with water while the top layer was dry. This allowed the earthworms to find optimum moisture conditions in the test buckets.

Earthworms were also field exposed in 7.6-1 buckets, then recovered and transported back to WES for analysis. Both field-exposed and laboratory-exposed earthworms were purged for 48 hr at 10° C on moist filter paper prior to chemical analysis. Each tissue sample was homogenized using a PT 10/35 Brinkman Homogenizer equipped with a PTA 20S titanium blade. The resulting homogenate was divided into two subsamples and wet-digested (5 g for heavy metal and 10 g for PCB analyses).

Tissues and substrates were analyzed for heavy metals using atomic absorption spectroscopy and EPA sample digestion procedures (Delfino and Enderson 1978). Test samples were analyzed for cadmium, copper, chromium, lead, nickel, and zinc using a Perkin-Elmer Model 2100 Heated Graphite Atomizer and a Perkin-Elmer Model 5000 Atomic Absorption Spectrophotometer. Mercury was determined using a Perkin-Elmer Model 503 Atomic Absorption unit using the cold vapor technique. Arsenic was determined using a Perkin-Elmer Model 305 Atomic Absorption unit with a MHS-10 hydride generator.

Techniques for hydrocarbon analyses of earthworm tissues and substrates also followed recommended EPA procedures (EPA 1982). Organic compounds in sediments were extracted using a hexane-acetone solvent, and those in tissues were extracted with 4-percent sodium hydroxide. PCBs were determined following solvent extraction and silica gel cleanup by means of electron capture gas chromatography. The PAH fraction was separated by silica gel chromatography and subjected to capillary gas chromatography.

## Results

### Quality of Soil Water

During the first 2 years after site construction, soil water was sampled at three depths in the treated plots and at one depth in the control plot. The three depths chosen for the pressure-vacuum samplers placed in treatment plots assured that samples represented: (a) the dredged material,

(b) the dredged material/mine spoil interface, and (c) the mine spoil. The data in Table 3 indicate that the pH of the dredged material near the surface dropped slightly with vegetation establishment, then remained relatively constant. Note that below the dredged material/mine spoil interface, the soil water became less acidic.

Quality of Runoff Water

The pH and acidity of the runoff collected during a storm event reflect the physical effectiveness of using dredged material in pyritic mine spoil restoration insofar as its capacity to reduce acid runoff (Table 4). Extensive analyses of the runoff for heavy metals were conducted, and no movement of toxic metals in the dredged material was noted. All metals were below detection limits in runoff water.

Vegetation

During the year in which the plots were planted (1978), the floristic composition of the three plots consisted of a vigorous flush of ubiquitous annuals (common ragweed, beggarsticks, black mustard, and heartsease). Of the species planted in the treatment plots, only perennial rye was present in significant stands. Switchgrass and Kentucky bluegrass were not evident at all, though they later became established in each plot. Tall fescue, smooth brome, and birdsfoot trefoil appeared only occasionally and were visually overwhelmed by the colonizing annuals.

By 1979, it was apparent in the treated plots that two of the planted perennial grasses (smooth brome and tall fescue) were becoming well established and the annuals were much less evident. In low areas, stands of common burdock and beggarsticks were common. The control plot continued to contain only scattered clumps of smooth brome and tall fescue in its drier, eastern two subplots while the other three subplots were barren.

By 1980, the three treatment plots had become almost completely vegetated by a mix of smooth brome and tall fescue. The control plot remained largely bare of vegetation, though in areas where plants had been growing, switchgrass was becoming dominant. In 1985, the species composition of all plots changed by an average of 49 percent. Even the dominant species changed rather dramatically over the 5-year period, especially in Plot 4.

Table 2 summarizes major vascular plant species in each of the four plots as perceived in the spring of the year. Each species is represented by a modified importance value expressed as a percent. The table also shows changes in species composition from year to year, expressed as changes in similarity coefficients. Each succeeding year is increasingly different from 1980, the year in which systematic vegetation sampling began. The total number of species in each plot each year is indicated at the bottom of each plot table.

Most of the species present represented less than 3 percent of the total phytomass; however, in Plot 2 in 1980, tall fescue and smooth brome comprised 86 percent of the total. The other 14 percent was constituted by an aggregate of another 29 species. Each of these minor species, while individually

interpretable as insignificant, may in fact play significant roles in the physiochemical evolution of the developing soil horizons.

## Contaminant Mobility

The results of heavy metal analyses for Plots 2, 3, and 4 of the field bioassay study conducted in 1981 are compared in Table 5 with the analysis of dredged material reported by Perrier et al. (1980) and the results of a field survey of nutsedge growing in naturally occurring wetlands around the Great Lakes by Simmers et al. (1980). The limited colonization of the control plot by plants was not within the scope of this contaminant mobility and succession study. These results indicate that, in spite of the relatively high substrate metal concentrations, plant intake was within the ranges of naturally occurring plants. The mean concentrations of cadmium and copper in the leaves of the bioassay plants were slightly elevated. Lead, nickel, and chromium were not accumulated to any significant extent.

Heavy metal contents of fescue and smooth brome were determined shortly after the experimental plots were constructed. Statistical analysis indicated no significant trends in the variation among all subplots of the treated plots. An analysis of variance showed no significant differences to indicate any contaminant concentration gradients at the site, either along the slopes or across the plots. Based on these results, the smooth brome and fescue data are shown as means for the dredged material portion of the field site (Table 6). Observed changes in floristic composition suggested potential changes in rhizosphere environment, so that plant heavy metal concentrations were evaluated again in 1983. Interestingly, over the 4-year period, fescue had declined to the point where sufficient phytomass for replicated sampling was unavailable. For smooth brome, however, bioavailability of at least copper, lead, and nickel appeared to have changed. Neither smooth bromenn or fescue contained a high cadmium level. The fescue did appear, however, to have accumulated lead and nickel to levels that may be of possible concern though there are no applicable FDA action levels. At the time the data were collected, smooth brome was responsible for comparatively little heavy metal uptake. Had the fescue remained a major part of the ecosystem, management procedures might have been necessary to retard movement of heavy metals into other levels of the ecosystem.

A comparison of the earthworm tissue levels of metals from the three test media is shown in Table 7. Smooth brome and fescue were collected and analyzed earlier and are the source of the thick leaf litter or duff layer on the now grass-dominated plots. Cadmium appears to be available from the leaf litter layer while copper and nickel appear to be more available in the dredged material. Lead is apparently equally available in all three media.

The field screening bioassay for PCBs and PAHs was an attempt to apply current analytical capabilities not previously available to an older site where a major contaminant may have been overlooked. These data are shown in Table 8. PCB congeners were present in low levels in the earthworm tissues, but they may have been present originally in higher levels had earthworms been exposed at the disposal site in Alsip where the material was dewatered. Similarly, PAHs were also present in earthworm tissues.

## Discussion

### Soil Water and Runoff

The basic objective of the demonstration project was accomplished as demonstrated by the quality of the soil water and runoff data collected. The regrading of pyritic mine spoil and application of a dewatered dredged material cover halted acid runoff. The pH at the dredged material/mine spoil interface remained near neutral, and vegetation was established. From a simple restoration viewpoint, the project should be considered successful and serve as an example for pyritic surface mine spoil restoration. There was no indication in the physical data to recommend the application of lime at the interface; it appears from a soil water pH view that the dredged material alone was satisfactory. The lime rate, however, may have had an impact on the successional patterns in the plant communities developing on the site.

At this point, the restoration portion of the project is complete. The following discussion will address the ecosystems which are becoming established and the movements in the ecosystem of contaminants from this particular dredged material.

### Vegetation

From the first year until the present, the vegetation has continued to change and to progress beyond the previous year. Changing soil horizons and the development of a rhizosphere consisting of a slowly changing root-soil chemistry are evidently changing the physiochemical character of the dredged material.

Once a homogeneous mixture of barge canal sediment, the dredged material is becoming increasingly stratified and chemically diverse. It is becoming clear that one of the challenges facing practitioners who attempt to restore any kind of land is to come to understand that pedogenesis and plant succession will be ongoing factors and that their impact on developing ecosystems will have to be addressed. It will be necessary to understand what factors control the kinds of plant succession which can occur under a given set of conditions. At Ottawa it is likely that succession would have been more toward woody vegetation had grasses not been planted on the site. Trees such as ashes, boxelders, elms, cherries, and cottonwoods occur on similar mining sites. In this case, the effect of rhizosphere development and contaminant movement patterns quite different from what we see today would have occurred. An inevitable succession will occur at each site and progress according to the initial availability of seeds and diaspores. For this reason, it is apparent that a "no management" plan must be regarded as an active management plan on both dredged material and mine-spoil sites.

### Contaminant Mobility

The incidental presence of heavy metals in the dredged material at the Ottawa demonstration site appeared to have little direct effect on the plant community. If there were an effect, it is likely that macroecological factors involving early successional competition has muted it. Both of the dominant

grasses in the demonstration plots contained negligible tissue levels of heavy metals when analyzed. Results from the application of the field version of the WES plant bioassay suggest that there is no unusual movement of contaminants from this dredged material into the vegetation. The only notable situation that could be contaminant-mediated was the decrease in fescue at the site concurrent with relatively elevated lead tissue levels. At this time, this can only be considered a coincidence and not a selection of successional species by contaminant influence. Other than the lead levels in fescue (Table 6), dominant plants and bioassay plants did not indicate contaminant levels beyond what is occurring in reference populations found in the Great Lakes area.

Earthworm bioassay procedures conducted in the growth chamber and screening tests conducted in the field did indicate areas of potential concern. Table 7 indicates a potential route of bioaccumulation of cadmium by the earthworm in a laboratory setting. The presence of earthworms which feed in the leaf-litter zone could allow a significant flow of cadmium from dredged material through the earthworm to predators. This route of contaminant movement has not been verified in the field at the Ottawa site.

The presence of PCB congeners and PAH's in the test earthworms is probably quite typical for older dredged material disposal sites. It is suspected that, at the time of dredging, many organic contaminants were present. The levels accumulated by the earthworm biomonitors may well reflect PCB and PAH levels below detection limits in the dredged material at that time.

## Summary and Conclusions

Dewatered dredged material can be used effectively in the reclamation of pyritic mine spoil. The demonstration project described here showed that a cover of dredged material stopped acid runoff while allowing speedy revegetation.

The vegetation now established at the site is changing in composition at a steady rate; pedogenesis is under way. How changes in contaminant movement will be expressed is the object of continued research as is research into how management protocols can be used to control these processes to produce positive results.

Although some heavy metals, PCB's, and PAH's are present, there do not now appear to be any potential routes of contaminant uptake other than the movement of cadmium from leaf litter as indicated by the bioassay earthworms. The presence of low levels of contaminants in dredged material need not eliminate it from consideration for a productive use. However, it is necessary to conduct the appropriate bioassay monitoring procedures and to be prepared to implement appropriate management strategies consistent with the productive use.

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Figure 1. An aerial view of the demonstration reclamation site and the pyritic overburden from strip mining at Ottawa, IL. Plot 4 is on the left with the control Plot 1 on the right. Note the Parshall flumes in the upper right-hand corner of each plot

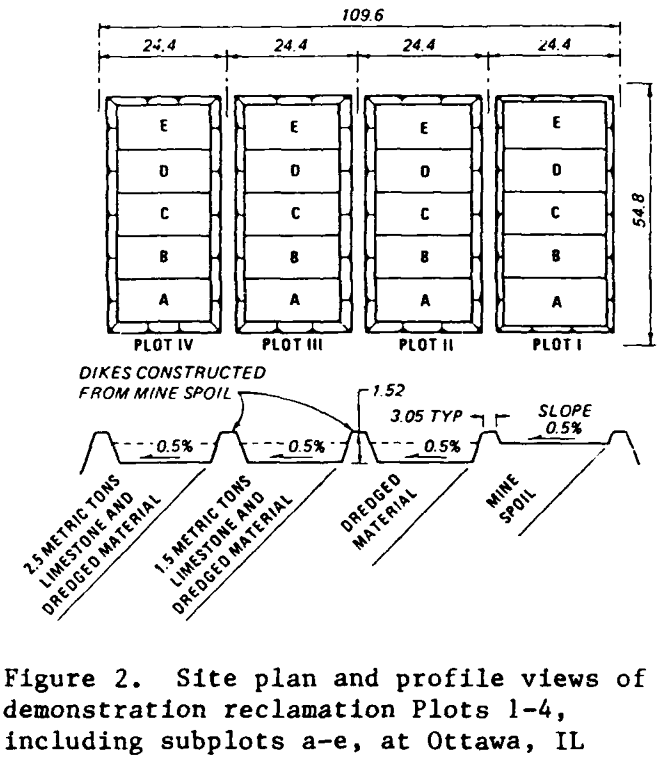


Figure 2. Site plan and profile views of demonstration reclamation Plots 1-4, including subplots a-e, at Ottawa, IL (Perrier et al. 1980)

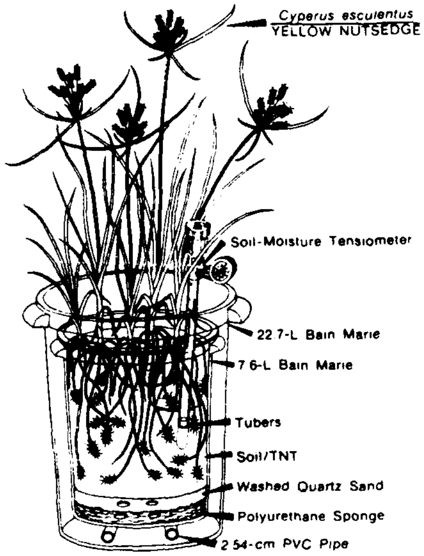


Figure 3. A schematic of the plant bioassay double bucket apparatus designed by WES (Folsom et al. 1981)

Table 1

Plant Species Seeding and their Rates of Application at the Ottawa, IL, Strip Mine Demonstration Reclamation Site, 1978

| Seed Mixture | | Application Rate: kg ha$^{-1}$ |
|---|---|---|
| **Grasses** | | |
| Kentucky Blue Grass (*Poa pratensis*) | | 17 |
| Kentucky 31 Tall Fescue (*Festuca arundinacea*) | | 22 |
| Lincoln Smooth Brome (*Bromus inermis*) | | 17 |
| Blackwell Switch Grass (*Panicum virgatum*) | | 22 |
| Perennial Rye (*Lolium perenne*) | | 17 |
| **Legume** | | |
| Bird's Foot Trefoil (*Lotus corniculatus*) | | 17 |
| | Total | 112 |

Table 2

Summary of the Major Vascular Plant Species and their Relative Importance (by Percentage) and the Changes in Species Composition between Spring Seasons in Each of the Four Demonstration Reclamation Plots at Ottawa

**Plot 1**

| | | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| Smooth brome | | 9 | 1 | 2 | 1 | 8 | 13 |
| Tall fescue | | 57 | 17 | 4 | 7 | 30 | 10 |
| Yellow sweet clover | | 1 | 23 | 5 | 20 | - | - |
| Switch grass | | 31 | 56 | 79 | 64 | 50 | 57 |
| Wild black cherry | | | | 1 | 1 | 1 | 8 |
| Coefficients of similarity | 1980 | 100 | 67 | 44 | 46 | 44 | 42 |
| | 1981 | | 100 | 65 | 66 | 58 | 54 |
| | 1982 | | | 100 | 89 | 75 | 70 |
| | 1983 | | | | 100 | 87 | 71 |
| | 1984 | | | | | 100 | 83 |
| Total number of species | | 7 | 11 | 20 | 19 | 20 | 26 |

**Plot 2**

| | | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| Smooth brome | | 77 | 90 | 91 | 94 | 89 | 94 |
| Field thistle | | - | - | 1 | 1 | 4 | 2 |
| Tall fescue | | 9 | 1 | 1 | 1 | - | - |
| Coefficients of similarity | 1980 | 100 | 79 | 72 | 62 | 57 | 52 |
| | 1981 | | 100 | 30 | 62 | 60 | 59 |
| | 1982 | | | 100 | 72 | 73 | 64 |
| | 1983 | | | | 100 | 88 | 69 |
| | 1984 | | | | | 100 | 73 |
| Total number of species | | 31 | 37 | 38 | 37 | 36 | 27 |

**Plot 3**

| | | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| Smooth brome | | 85 | 90 | 84 | 91 | 83 | 93 |
| Grass-leaved goldenrod | | - | 1 | 6 | 1 | 2 | |
| Bird's foot trefoil | | 1 | 1 | 2 | 2 | 1 | 3 |
| Kentucky blue grass | | 1 | 1 | 1 | 2 | 1 | 1 |
| Tall goldenrod | | 1 | 1 | 3 | - | - | - |
| Tall fescue | | 2 | 1 | 1 | 1 | | |
| Common ragweed | | 2 | 1 | 1 | - | - | - |
| Switch grass | | - | - | - | - | 2 | 1 |
| Orchard grass | | 2 | 1 | - | - | | |
| Coefficients of similarity | 1980 | 100 | 87 | 65 | 55 | 49 | 44 |
| | 1981 | | 100 | 75 | 58 | 59 | 49 |
| | 1982 | | | 100 | 69 | 68 | 61 |
| | 1983 | | | | 100 | 77 | 67 |
| | 1984 | | | | | 100 | 72 |
| Total number of species | | 23 | 30 | 39 | 39 | 34 | 27 |

**Plot 4**

| | | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| Smooth brome | | 74 | 67 | 50 | 76 | 56 | 71 |
| Grass-leaved goldenrod | | 1 | 2 | 18 | 6 | 14 | 5 |
| Tall fescue | | 16 | 5 | 3 | 1 | 1 | - |
| Tall goldenrod | | 1 | 2 | 6 | - | 7 | 2 |
| Kentucky blue grass | | - | 11 | 7 | 3 | 2 | 3 |
| Bird's foot trefoil | | 1 | 1 | 3 | 1 | 2 | 3 |
| Reed canary grass | | | 1 | 1 | 4 | 4 | - |
| Field thistle | | - | - | 4 | 2 | 1 | 2 |
| Evening primrose | | - | 1 | 1 | 2 | 1 | 3 |
| Hairy chess | | 1 | 5 | | | | |
| Downy brome | | 1 | 5 | | | | |
| Annual sunflower | | 1 | 1 | 1 | - | 1 | - |
| Common ragweed | | 1 | 1 | 1 | - | - | 1 |
| Switch grass | | - | - | - | 1 | 1 | 2 |
| Blue vervain | | | | - | - | 1 | 2 |
| Yellow sweet clover | | 1 | 1 | - | - | | |
| Coefficients of similarity | 1980 | 100 | 84 | 71 | 60 | 54 | 59 |
| | 1981 | | 100 | 78 | 71 | 62 | 72 |
| | 1982 | | | 100 | 78 | 75 | 79 |
| | 1983 | | | | 100 | 79 | 73 |
| | 1984 | | | | | 100 | 81 |
| Total number of species | | 23 | 34 | 40 | 42 | 43 | 46 |

Table 3

Soil Water pH in Control and Treatment Plots at Ottawa (Summarized from Harrison and van Luik 1980)

| | | | pH on Sampling Dates | | | | |
|---|---|---|---|---|---|---|---|
| Plot | Treatment | Meter Depth | Nov 1977 | Jun 1978 | Nov 1978 | May 1979 | Sep 1979 |
| 1 | untreated mine spoil | 0.6 | 5.4 | 3.8 | 3.5 | 3.7 | 3.4 |
| 2 | no lime added | 0.6 | 8.0 | 6.7 | 7.7 | 6.5 | 6.7 |
| | | 0.9 | 8.0 | 6.6 | 8.0 | 6.5 | 6.7 |
| | | 1.5* | 5.4 | 5.8 | 4.8 | 5.0 | 6.4 |
| 3 | 11 tons/ha lime | 0.6 | 8.0 | 6.9 | 7.5 | 6.5 | 6.7 |
| | | 0.9 | 7.9 | 6.7 | 6.8 | 5.5 | -- |
| | | 1.5* | 2.5 | 2.9 | 2.6 | 5.6 | 5.7 |
| 4 | 17 tons/ha lime | 0.6 | 8.0 | 6.8 | 7.7 | 6.5 | 6.7 |
| | | 0.9 | 5.7 | 6.6 | 7.1 | 6.6 | 6.8 |
| | | 1.5* | 4.6 | 3.9 | 4.0 | 6.5 | 6.7 |

* The 1.5 m depth in Plots 2-4 is below the applied dredged material and in the original mine spoil.

Table 4

Selected Runoff Water Quality Values Collected during a Storm Event on 10 April 1978 (Harrison and van Luik 1980)

| | Control Plot (1) | | Treated Plots (1, 2, and 3) | |
|---|---|---|---|---|
| Substance | High Value | Mean Value | High Value | Mean Value |
| pH | 3.34 | 3.52 | 7.15 | 7.28 |
| Acidity, mg/ℓ | 1,340 | 582 | 20 | 16 |
| $PO_4$, mg/ℓ | 0.05* | 0.05* | 0.06 | 0.05* |
| TKN, mg/ℓ | 0.85 | 0.65 | 1.80 | 0.95 |
| $NH_3$, mg/ℓ | 0.42 | 0.65 | 0.25 | 0.22 |
| $NO_3$, mg/ℓ | 3.0 | 0.33 | 0.32 | 0.32 |
| $SO_4$, mg/ℓ | 1,500 | 2.2 | 300 | 131 |
| Fe, mg/ℓ | 3.66 | 633 | 1.34 | 0.50 |
| Cℓ, mg/ℓ | 1.0* | 1.22<br>1.0* | 6.0 | 1.2 |

* Below detection limits.

Table 5

Contaminants in Dredged Material and in Bioassay Plant Tissues, 1981

| Contaminant | Dredged Material* (n=4) Mean ± Standard Deviation | Field Plant Bioassay (n=16) Mean | Field Plant Bioassay (n=16) Range | Field Survey** (n=31) Mean | Field Survey** (n=31) Range |
|---|---|---|---|---|---|
| As | -- | | | d | |
| Cd | 13.0 ± 0.6 | 0.81 | 0.56-1.37 | 0.51 | d-1.78 |
| Cr | 165.6 ± 4.9 | d | | 2.35 | d-10.30 |
| Cu | 113.0 ± 13.2 | 12.26 | 9.65-19.20 | 6.53 | d-26.96 |
| Pb | 507.0 ± 7.0 | 0.93 | 0.69-1.15 | 5.22 | d-43.56 |
| Ni | 53.2 ± 3.5 | d | | 3.29 | d-12.20 |
| Zn | 1,123.0 ± 53.0 | 84.2 | 63.3-106.0 | 74.8 | 8.6-237.1 |
| Hg | 0.9 ± 0.3 | -- | | d | |

Note: d = detection limit.
* From Perrier et al. (1980).
** From Simmers et al. (1980).

Table 6

Mean Contaminant Levels in Two Dominant Plant Species in the Treated Demonstration Reclamation Plots 2-4 at Ottawa

| Contaminant | Substrate* (n=4) | Festuca (n=9) 1979 | Bromus (n=16) 1979 | Bromus (n=14) 1983 |
|---|---|---|---|---|
| As | - | d | d | d |
| Cd | 13.0 ± 0.6 | 1.05 ± 0.73 | 0.78 ± 0.57 | 0.94 ± 0.25 |
| Cr | 165.6 ± 4.9 | 5.45 ± 1.53 | 2.94 ± 0.59 | 1.72 ± 0.39 |
| Cu | 113.0 ± 13.2 | 5.11 ± 1.65 | 7.67 ± 1.09 | 15.94 ± 2.24 |
| Pb | 507.0 ± 7.0 | 12.17 ± 2.4 | 3.25 ± 1.46 | 3.80 ± 0.80 |
| Ni | 53.2 ± 3.5 | 5.15 ± 2.14 | 3.21 ± 0.93 | 1.64 ± 0.46 |
| Zn | 1123.0 ± 53.0 | 72.43 ± 13.46 | 55.49 ± 12.35 | 75.54 ± 14.70 |
| Hg | 0.9 ± 0.3 | d | d | d |

Note: d = detection limit.
* From Perrier et al. (1980).

Table 7

Contaminant Concentrations in Earthworms, Leaf Litter, and Substances from Treated Plots 2-4 at Ottawa, 1983

| Test Material | Cd | Cu | Pb | Ni |
|---|---|---|---|---|
| Background | | | | |
| Earthworm | 3.67 ± 0.51 | 9.55 ± 1.00 | 1.50 ± 0.65 | 2.00 ± 0.77 |
| Earthworm | 14.07 ± 5.37 | 9.17 ± 1.56 | 2.17 ± 0.46 | 1.87 ± 0.46 |
| Leaf litter | 3.27 ± 0.73 | 15.66 ± 1.65 | -- | 5.89 ± 0.20 |
| Earthworm | 9.03 ± 0.89 | 25.83 ± 4.20 | 2.87 ± 0.69 | 5.23 ± 0.61 |
| 30-cm depth* | 10.00 ± 0.50 | 127.00 ± 8.60 | 620.00 ± 69.90 | 51.50 ± 3.20 |
| Earthworm | 8.23 ± 0.21 | 25.37 ± 1.03 | 5.27 ± 2.00 | 5.33 ± 0.31 |
| 100-cm depth* | 9.18 ± 1.63 | 116.7 ± 10.30 | 585.00 ± 22.80 | 50.10 ± 2.16 |

* Dredged material.

Table 8

Concentrations of Selected PCBs and PAHs in Experimental Worms Exposed to Dredged Material for 28 Days at the Ottawa Site, 1983

| PCB's, $ug.kg^{-1}$ | Worm Tissue Concentration |
|---|---|
| 2,5,2',5' Tetrachlorobiphenyl | 53.0 |
| 2,4,5,2',5 Pentachlorobiphenyl | 87.0 |
| 2,4,5,2',4',5' Hexachlorobiphenyl | 270.0 |
| 2,3,4,2',4',5' Hexachlorobiphenyl | 300.0 |
| 2,3,4,5,2',4',5' Heptachlorobiphenyl | 210.0 |
| PAHs, $ug.g^{-1}$ | |
| Anthrene | 0.10 |
| Benzo (b) fluoranthene | 0.18 |
| Benzo (k) fluoranthene | 0.14 |
| Benzo (g,h,i) perylene | 1.90 |
| Benzo (a) pyrene | 0.39 |
| Benzo (c) pyrene | 0.46 |
| Chrysene | 0.10 |
| Dibenzo (a,i) anthracene | 0.71 |
| Dibenzo (a,i) pyrene | 0.77 |
| Perylene | 0.14 |
| Phenanthrene | 0.12 |
| Pyrene | 0.11 |
| Triphenylene | 0.11 |

QUESTION: I am wondering about increased diversity on sites such as this one. What do you think about using native versus nonnative plants on disposal sites and on other sites?

DR. WILHELM: Let me answer that question with a question. What if we planted our site with one or more particular plant species, and the site is functioning normally by every test and sign? However, years down the road, we found say 1 ppm cadmium in the earthworms on the site. What does that mean to the overall created habitat? Is it good or is it bad? Is the site suddenly now no longer good, and how could native or nonnative species have any impact on that at all?

QUESTION: Let me rephrase that. I am concerned about the use of introduced plant species on development sites when we don't know enough about our 5,000+ native plant species. Shouldn't we be looking at them first?

DR. WILHELM: Yes, we haven't begun to learn all there is to know about these species. However, we should not ignore introduced species if they accomplish our purpose.

## SESSION III: INNOVATIVE BENEFICIAL USES AND CONCEPTS

# BENEFICIAL USES OF DREDGED MATERIAL IN SEVEN NEW ENGLAND PROJECTS

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East Longmeadow, Massachusetts

## Introduction

Dredging is becoming increasingly utilized as a method for restoring eutrophic lakes in New England. Dredging has been shown to improve water quality, reduce aquatic macrophyte growth, and restore lost recreational amenities by physically deepening the lake, as well as by removing oxygen demanding, nutrient-rich organic bottom materials. The number of actual dredging projects being carried out has increased over the past few years due to active funding programs which have been instituted in individual states.

This paper examines the ultimate dredged material uses for seven projects in New England in which dredging is being utilized as a lake-restoration technique. The type of dredge used is discussed along with the overall characteristics of the dredged material and the design removal volumes for each project. All seven projects utilize confined upland disposal sites. The ultimate disposal use of the dredged material along with its impact on project costs to data is summarized for each project.

The seven projects are located in Connecticut or Massachusetts. The three projects in Connecticut include: (a) Bantam Lake at Morris and Litchfield, dredged from 1978 to the present; (b) 1860 Reservoir at Wethersfield, dredged from 1984 to the present; and (c) Gorton Pond at East Lyme, dredged in 1984. The four projects located in Massachusetts include: (a) Nutting Lake at Billerica, dredged from 1978 to 1985; (b) Dunn's Pond at Gardner, dredged in 1983 and 1984; (c) Willow Lake at Northampton, dredged in 1985 and 1986; and (d) Porter Lake at Springfield, scheduled to be dredged in 1988 and 1989. Four of the seven projects are partially funded by the EPA through their Clean Lakes Program. All seven of these projects are partially financed by State and local agencies.

## Objective of the Projects

The overall objective in these relatively small projects is to restore or improve recreational amenities which have been lost over the years due to siltation and the process of eutrophication. The primary goal of the dredging portion of these projects is to physically deepen the lakes, remove existing nuisance aquatic macrophytes along with their root systems, and eliminate or retard their regrowth.

Many of the recreational lakes in the northeast, especially those in public parks, are relatively small impoundments with substantial watershed development. These impoundments have effectively served as sediment traps over the years and have typically become quite shallow with excessive macrophytic growth. Clearly, dredging is the only efficient and cost-effective means available to remedy this condition.

## Selected Dredging Methodologies

Artificial impoundments which can be drained can be dredged by either of two methods; conventional earthmoving equipment or a hydraulic dredge. The cost-effectiveness of each of these methods was evaluated for the individual projects during their design phases. Typically, each was dependent upon the ability of the lake to be thoroughly drained, the physical characteristics of the organic bottom materials to be removed, and the availability of disposal areas for the dredged material.

Conventional methods of excavation were utilized in the Dunn's Pond, Gorton Pond, and Willow Lake projects. The inability to drain the lakes, coupled in some cases with the need to project the existing water resources during dredging, led to the selection of hydraulic dredging as the preferred method in each of the other four projects.

Land availability, environmental factors, and construction cost considerations have limited the available containment area size in the hydraulic dredging projects. The containment area storage volumes ranged from approximately 25,000 cu yd to approximately 100,000 cu-yd. These relatively small volumes limit the flow rate at which dredged material can be pumped into the containment area and, therefore, the dredge size. A Mud Cat Model MC-915 was the selected dredge for the hydraulic dredging projects.

Actual hydraulic dredge production rates encountered in these projects have ranged from approximately 25 cu yd/hr to in excess of 100 cu yd/hr. Production rates have varied with the type of material being excavated and the experience of the dredging crew. An average production rate for work completed to date is in the range of 40 to 50 cu yd/hr of project time.

## Characteristics and Volumes of Dredged Material

The material being dredged on these projects ranges from almost pure fibrous peat to fine-grained organic silt to sand. Rock and hardpan (compact glacial till) was encountered in one area on the Bantam Lake project. The material being excavated at Dunn's Pond is a fibrous peat underlain by organic silt deposits and till. Organic contents of the dredged material in the various projects ranged from 3.5 to 70 percent.

The predominant type of material being dredged in each of the lakes and the total project volumes are listed in Table 1. Bulk chemical analyses, including EPA toxicity testing, were carried out on the dredged material in

order to obtain Section 401 water-quality certification. To date, none of the sediments has exceeded the EPA/State maximum allowable contaminant levels.

## Containment Area Design

The seven projects utilized upland dike dredged material containment areas. The capacity and specific geometry of the basins was a function of site availability and topography as well as the dredging methodology. In each of the projects, attempts were made to select a containment area where the existing topography would reduce the amount of embankment construction required. The containment area embankments were constructed from onsite material for each project. The maximum embankment heights are < 25 ft.

Containment area effluent water quality guidelines have varied from essentially subjective visual assessments to specific turbidity levels. A discharge water turbidity limit of 10 NTU was established for the Dunn's Pond and Nutting Lake projects. Chemical flocculation, followed by quiescent settling, was necessary to achieve the desired effluent quality on four of the hydraulic dredging projects.

It was not possible to develop a containment area of sufficient size to store the entire volume of dredged material for four of the projects, all hydraulically dredged. It was therefore necessary to remove the dredged material from the containment areas in order to complete the dredging program. The potential reuse of the dredged material coupled with the difficulty of physically removing the material from the containment areas played a major role in determining the overall project time frame and costs.

## Dredged Material Reuse

Because of the significant administrative and financial involvement of the local communities in these projects, the first option for the ultimate use of the dredged material is usually on public sector projects. The overall objective for most lake-dredging projects is recreational in nature, and there is a tendency to use the dredged material for nearby recreation based projects; i.e., parks and ballfields.

The specific reuse of the dredged material on the projects discussed herein is somewhat varied but basically has been either for landscaping improvements or landfill cover material. Sanitary landfills remain the principal method of solid waste disposal in New England. Many communities, particularly in the more urban areas of southern New England, are faced with purchasing cover material for landfill operation and ultimately for final closure. With the exception of the fibrous peat and organic mulch samples, the dredged lake material typically satisfied the state guidelines for landfill use with regard to bulk chemistry and grain distribution.

Highly organic dredged lake material can be mixed with sand to create a topsoil for landscaping or landfill final cover material. Testing of the

dredged material on the seven projects has shown the fertility to be varied with nitrate-N and potassium typically low and phosphorus typically high to very high. The material tends to be somewhat acid with a pH usually in the 5.3 to 5.8 range. The addition of lime and fertilizer is usually necessary to promote an optimum growth environment. The fine-grained organic mucks significantly improve the moisture-holding capacities when mixed with coarse-textured soils.

Experience on the projects has shown that the magnitude and time rate of improvement of their engineering properties are significant factors influencing the potential reuse of dredged material. Subsequent to deposition in the containment area, a number of processes take place which result in the dewatering and consolidation of the dredged material. These processes may include gravity drainage, consolidation under an overburden pressure or due to seepage forces, evaporation and transpiration due to vegetation growing in the containment area. Designs that permit rapid and economical dewatering of dredged material, in turn, yield a more feasible and economic product from potential reuse. Table 2 lists the various reuses of the dredged material on the seven projects.

## Impacts on Project Costs

Income may be realized in a lake-dredging project from two sources: (a) sale of dewatered dredged material; and (b) sale of the containment area at the conclusion of the project. The value of dredged material depends on the characteristics of the material and the proximity of the containment area to the location where such material might be needed. Excavation and transportation costs can quickly negate any profit to be made from the use of the dredged material, so it is essential that the material be thoroughly dewatered and the ultimate use site be as close as possible to the lake.

Dredged material can also be used as topsoil/landscaping fill to reclaim marginal lands and/or the containment area itself. Selection of such locations for containment areas, with final regrading and appropriate planting, can transform land of minimal value into a substantial asset. Use as recreational land or sale for other purposes can yield a sizeable profit.

With the exception of the Bantam Lake and Nutting Lake projects, reuse of the dredged material has not had an easily quantifiable impact on project costs. The dredged material from Bantam Lake is offered for sale at the containment area. The cost is $0.25/cu yd, with the buyer responsible for loading and hauling. All material produced to date has been sold. Ultimately, the project should achieve a return of approximately $50,000.

On the 1860 Reservoir project, the dredged material is being stockpiled for landscaping use on an arterial highway project which will soon be under construction through the containment area. Although no money will be returned directly to the dredging project, the town and state will receive a financial benefit relative to the highway construction project.

On Dunn's Pond, Willow Lake, Gorton Pond, and Porter Lake projects, the primary use for the dredged material is for park landscaping and playfield construction projects. Some material from Porter Lake may also be used as final landfill cover by the city of Springfield. Although there will be no direct financial benefit to the dredging program on these projects, the local communities will be receiving significant financial benefits as a result of the dredged material reuse.

The Nutting Lake project, begun in 1978, has had varied experiences with dredged material reuse. Material removed from Nutting Lake was of suitable nature and appropriate proximity for profitable sale as landfill cover material, but inadequate dewatering resulted in difficulties in removing the material from the containment area and a decline in the potential sale price from $1 to $0.30/cu yd and finally to zero. Fortunately, it did not become necessary to pay to have the material removed from the containment area, but the town of Billerica experienced great difficulty in arranging for the timely removal of accumulated sediment. A potential benefit became a liability, and only about $18,500 in income was received through the sale of dredged material.

The containment area which received dredged material at Nutting Lake was built on town property of apparent marginal value when the project began, but the filling of this site along with the purchase of most of the nearby property for a high technology industrial park caused land values to rise sharply. The town of Billerica sold the containment area to the development corporation associated with the industrial park for approximately $450,000 at the conclusion of the dredging project. The site is currently under development. The owner is mixing the remaining dredged material with sand and is using it as topsoil onsite and other projects.

The value of the land in the absence of the containment area is not precisely known, but it is clear that the presence of a containment area did not in any way reduce the value of the original parcel and may have increased it appreciably. The income from the containment-area sale was divided among several town accounts. Some money was used to aid development of the new town beach on Nutting Lake, and some was used to purchase new conservation lands elsewhere in the town limits.

## Future Considerations

Based on the experience gained in the projects discussed herein, the following points are offered for consideration in future lake-dredging projects in order to maximize the beneficial use of the dredged material.

The containment areas should be designed to maximize the rate of drying of the dredged material and the ease of its removal. Consideration should be given to the use of underdrains to increase the vertical permeability and associated seepage stresses. Berms should be constructed to facilitate movement of equipment into and out of the containment area. Poor dewatering coupled with difficulties in removing the dredged material from the containment area can negate the potential value of the material.

Table 1

Volumes and Characteristics of Materials Being Dredged

| Project | Total Project Volumes, cu yd | Predominate Materials Being Dredged |
| --- | --- | --- |
| Nutting Lake | 361,000 | Organic silt |
| Bantam Lake | 232,000 | Organic silt areas of clay, sand and ledge/hardpan |
| Dunn's Pond | 163,000 | Fibrous peat some organic silt |
| Willow Lake | 10,000 | Fine sand, some silt |
| 1860 Reservoir | 140,000 | Organic silt |
| Gorton Pond | 210,000 | Fine sand and silt, areas of organic muck |
| Porter Lake | 120,000 | Organic silt and sand |

Table 2

Dredged Material Reuse

| "Project" | Dredged Material Reuse |
| --- | --- |
| Nutting Lake | Landfill cover material, topsoil for reclamation of containment area for industrial park |
| Bantam Lake | Sold onsite |
| Dunn's Pond | Construction of playing fields |
| Willow Lake | Construction of soccer field |
| 1860 Reservoir | Landscaping new highway corridor |
| Gorton Pond | Town landscaping projects |
| Porter Lake | Landfill final cover, park landscaping/ erosion control projects |

No income from the sale of dredged material should be assumed in planning a lake-dredging project unless a definite binding agreement has been reached. The least troublesome and potentially most rewarding use of dredged material has been in the reclamation of marginal land at or near the containment area. Minimal transport of dredged material is necessary in such cases, and substantial increases in land value are likely to be realized when the project is completed. Potential reclamation areas in close proximity to the lake to be dredged should be sought out and investigated prior to project design.

QUESTION: What was the cost per cubic yard of material dredged in these projects?

DR. WALSH: It cost anywhere from $2 to $5/cu yd. In these small projects, the cost was determined by the actual beneficial use of the material. Where resale of the dredged material occurred, the costs were more like $2/yd, but where we couldn't find any way to sell or reuse the material, the costs went up to $5/yd.

## SESSION III: INNOVATIVE BENEFICIAL USES AND CONCEPTS

# BENEFICIAL USES FROM DREDGED LAKE SEDIMENTS IN ILLINOIS

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## Introduction

Illinois has a relatively long history of dredging activities dating back to the work of Robert E. Lee on the Rock Island Rapids on the Upper Mississippi River. The Federal Rivers and Harbors Act authorized the CE to carry out improvements on the Ohio and Mississippi River in the 1800's. The earliest activities were essentially clearing and snagging work to maintain open channels for navigation on the rivers. Later, as the waterways of the Mississippi, Ohio, and Illinois Rivers were being developed, dredging was used to maintain minimum depths for navigation in the river channels.

Away from the larger rivers, inland dredging was used to straighten and enlarge smaller streams for agricultural drainage. Most of this type of work was performed by local drainage districts established for this purpose. In urban areas, dredging was used as a means of obtaining fill for swamp reclamation as well as to improve storm water drainage.

This paper will present an overview of case histories of beneficial uses of dredged material in the State of Illinois. The primary emphasis will be on lake dredging. The case histories presented are by no means the complete record of dredging in the state but are used to highlight the past and present activities to maximize the benefits from this resource. Figure 1 gives locations of 16 beneficial uses sites in Illinois.

The term beneficial is defined in the perspective of the observer. One person's opinion of perceived benefits may be viewed by another as destructive. For example, the filling of marsh and wetland areas was in the past considered an improvement in the environment. Today, with the recognition of the valuable function of wetlands, filling these areas is often viewed as destructive. It would be unfair to apply the perceptions of environmental management today to the actions of the past. Therefore, this paper will view past activities such as wetland filling and draining and wholesale channelization as benefits because at the time, the technology of dredging was selected and applied for what were seen as benefits.

In the late 19th and early 20th centuries, most dredging occurring away from the large rivers was conducted for drainage improvement. Usually the

dredged material was used for levee construction on adjacent streambanks. The benefits of using this material for levee construction was to provide a low-cost means of disposing of the material as well as providing a source of construction material to be used for controlling overbank flooding.

## Urban Activities

The principal use of dredged material in urban areas of the State was for filling low-lying land. In the Chicago area, vast amounts of dredged material were excavated from the rivers and lakes of the region to improve navigation and drainage. In Chicago in 1891, nearly 400,000 cu yd of sediment were dredged from the Calumet River (Colten 1985). Much of the material was used to fill cutoff meanders that resulted from the straightening and channelization of the river. Colten reported that although the records of disposal were incomplete, a great deal of the material dredged from the river was used to raise and grade the river's banks for industrial site development. In the 1890's, new industries were settling in the region, and many of them undertook private development of the Calumet riverfront, enlarging and deepening the river and using the material for improving their properties. Much of the material used to construct the Regional Port of Chicago on the Calumet River and Lake Calumet was obtained from dredging. Dredging was used as a source of fill for many of the industrial sites located on the various waterways of the city.

George Pullman, the famous manufacturer of railroad coaches, financed extensive dredging and filling projects for the construction of his factory town site on the shores of Lake Calumet. Colten reported that in 1880, Pullman used dredged material from the Calumet River and Lake Calumet to raise a 2- by 0.5-mile parcel of waterfront 5 ft above adjacent marshes. Dredging and filling continued on this site for several years as the Pullman facilities expanded. The bed of Lake Calumet was also used as a source of brick-making clay for the Pullman facilities. Colten quoted from a letter sent to the US Army from L. M. Johnson, "Brick is being manufactured at the rate of 100,000 per day when the season favors and this may soon be doubled." Dredging for brick-making clay extended 30 ft deep into the lake bottom.

In Peoria, IL, large quantities of construction aggregate are dredged annually from stream deltas built out into the Illinois River. After major storm events, contractors descend on the concrete-lined Farm Creek delta channel to excavate out gravels carried down from the bluffs of the Illinois River Valley. The aggregate is excavated from the channel using conventional earthmoving equipment at the contractor's expense, and detailed records are not kept. Aggregate stockpiles in the Farm Creek channel have been observed to reach heights of 20 to 30 ft before they are trucked out.

The city of Urbana, IL, in 1985, dredged out Crystal Lake, a recreation lake in one of the city's parks. The dredged material was loaded onto trucks and hauled to an old municipal landfill to regrade and cap the site.

Apple Canyon Lake property owners association in northwestern Illinois dredged 48,000 cu yd of sediment from their 440-acre lake in 1978. The

association used some of the material for landscaping and grading a site for parking lot construction.

## Rural and Agricultural Activities

Downstate Illinois is heavily dependent on surface water reservoirs for municipal, commercial, and industrial consumption. Many of the state's water supply and recreation lakes (like many in the US) are growing old and experiencing volume loss and use impairment caused by sedimentation. Most of the state's lakes were constructed from 20 to 70 years ago (Table 1) and are losing water storage and recreational use at a time when the need for these uses is increasing. Many of these lakes have seen volume losses in the range of 20 to 40 percent over the years. Among the many alternatives available to replace these lost uses is to rehabilitate the existing lake by dredging out accumulated sediments. Lake dredging in the state is increasing, and many Illinois towns and cities are considering dredging over new lake construction as a viable alternative to increase surface water resources.

A significant problem with the dredging for lake rehabilitation, as in all dredging efforts, is the disposal of dredged material. In 1951, the city of Macomb devised an innovative plan for disposal of material dredged from Spring Lake, their principal water supply. The material was hydraulically dredged out of the lakebed, pumped via pipeline through the lake, and disposed of over the lake's spillway. This plan was abandoned after 270,000 cu yd were removed from the lake due to a Department of Public Health ruling that the direct discharge of dredged material to the stream below the dam was unacceptable.

In the last few decades, the concerns of regulatory agencies over the safe disposal of dredged material, as well as the financial concerns of those considering dredging, have prompted new efforts in dredged material uses. Some of the recent work in Illinois for dredged material use had focused on agricultural applications. Agriculture, the largest land user and a significant portion of the state's economy, may provide the means for properly exploiting dredged material. Agricultural uses of dredged material may be a means of turning what some see as a waste product into a valuable commodity and brightening the economics of lake rehabilitation in the State.

The city of Carlinville in western Illinois hydraulically dredged 108,000 cu yd of sediment out of their water-supply lake between 1968 and 1972. The material was placed in a diked confinement area and seeded with winter wheat following the dredging work. Yields from the disposal area in the first year were 45 bushels/acre without the addition of fertilizer in spite of the lack of subsurface drainage which would have facilitated the drying of the primarily silt and clay dredged material.

The city of Oakland in east-central Illinois hydraulically dredged 95,000 cu yd of sediment from their water supply lake between 1972 and 1975, and the material was pumped into a disposal area built on leased uncultivated rolling land adjacent to the lake. Field tiles were installed in the 20-acre

diked disposal area to promote drainage. The dredged material was used to level off the land which was then converted into crop production.

Lake Paradise, a water supply lake for the city of Mattoon in east-central Illinois, was dredged in 1980 for a pilot study to demonstrate the benefits of using lake sediment as a soil additive (Lembke et al. 1983). The dredging demonstration was performed by the University of Illinois, the Illinois Departments of Energy and Natural Resources and Agriculture, the Illinois Agricultural Experiment Station, and the Water Resource Center. This work was undertaken to determine the feasibility of applying lakebed sediment to farmland and to study the resulting effects on crop yields. Chemical analysis of the lakebed sediment indicated the material was similar in fertility, trace metal, and organic chemistry to terrestrial soils (Stout et al. 1982). The sediment was determined to be cleaner than commercial soil amendments with respect to metals and organic pesticides. Fourteen test plots were established including four control plots where no sediment was applied. Results of the plots where sediment was applied showed a decrease of fertilizer needs which would save $23/acre and an increase in corn yields of 25 percent (Lembke et al. 1983). Net increase of return to the farm operator of $100/acre/year (excluding the cost of dredging and disposal) was projected due to increased yields and lower fertilizer costs in the dredged disposal areas when compared to control plots. The Lake Paradise project was relatively small scale, involving 2,300 cu yd of dredged material. The cost of lake dredging, material transport, and disposal were not included in the farm operator cost. If these costs were born by the lake owners, the project demonstrates that there were financial benefits to the farmland owners and an incentive to accept and use dredged material.

In 1982, the Northern Illinois Water Company was seeking a means of disposing of water-softening lime, a by-product of potable water treatment, that was filling up holding ponds in Urbana-Champaign. Discussions with engineers and agronomists at the University of Illinois and with Illini Farm Service led to investigations of the suitability of using the material for fertilizer. A Mud Cat dredge was used to hydraulically dredge the soft lime from the holding ponds and pump the material into sprayer trucks. The sprayer trucks were used to apply the lime to area fields. The experience of area farmers indicated that the soft lime had the benefit of covering the fields more evenly than traditional dry lime and the effects on the soil lasted longer. The cost of the soft lime is competitive with traditional dry lime and the current demand exceeds the available supply of 40,000 lb/year.

The city of Springfield is currently performing the most ambitious lake-dredging program in the state. Lake Springfield, the principal water supply for the city, is being hydraulically dredged of 2,700,000 cu yd of accumulated sediment. Dredging began in 1987 and is expected to continue through 1992. The dredged material is being placed into dike disposal areas adjacent to the lake. In order to recover some of the cost of the project, during the dredging phase all city-owned land surrounding the disposal area is planted in corn. Later, after the dredging is finished, plans call for cropping the entire 230-acre disposal site (Thomas M. Skelly, Supervisor of Water Resources, City of Springfield, IL, personal communication, 1987).

Olson and Jones (1987) conducted an investigation of the fertility of the lakebed sediment and studied the use of scrubber sludge and soil as amendments to the sediment. The city of Springfield funded the study to assess the usefulness of incorporating scrubber sludge generated at the city's coal-fired power plant and local soils to enhance the fertility of the dredged material. This study was part of an attempt to find beneficial uses of two dredged material soils. Currently, the city stores scrubber sludge in holding ponds, and in 1985 paid $585,000 to dispose of 59,000 tons of the material at a local landfill. Results of this study were based on greenhouse experiments where sudangrass was grown in various mixtures of sediment, soil, and scrubber sludge. Findings indicated that lakebed sediment had a higher fertility than local eroded soils. The scrubber sludge increased fertility in eroded soils, but its addition to lakebed sediment had little effect on fertility. The study found that if the city wanted to dispose of both the sediment and scrubber sludge, optimum results were obtained by mixing with eroded soil at proportions of 750 kg of sediment, 250 kg of soil, and 20 kg of scrubber sludge (Olson and Jones 1987). Although this study did not examine the economics of transporting and placing sediment and scrubber sludge, it demonstrates the potential uses of these dredged materials to agriculture.

## Summary and Conclusion

The potential uses of dredged material are very broad, ranging from construction to agriculture to consumer products. In any given discipline that uses earth materials, some potential exists for discovering economic benefits from the abundance of dredged material that currently exists. In the history of industry and commerce, some of the most prominent success stories were achieved by finding a means of turning waste products into raw materials. The successes of using dredged material for agriculture, construction, brickmaking, and other uses in Illinois are only a few potential successful uses. Among the many other uses that may be explored in the future are: (a) sanitary and hazardous landfill capping; (b) strip-mine reclamation; and (c) underground mine-subsidence control. In the future, it is likely that as more lake owners pursue dredging as a means of lake rehabilitation, the creative and entrepreneur energies of government and businesses will find additional means of exploiting this resource.

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Table 1

Recent Lake Dredging Projects in Illinois (Bhowmik et al. 1987)

| Lake* | Year Constructed | Year Dredged | Volume Dredged 1,000 cu yd | Cost/ cu yd** | Disposal Method |
|---|---|---|---|---|---|
| Spring Lake-Macomb | 1927 | 1951 | 270 | $0.30 | Discharge to creek downstream |
| Carlinville | 1938 | 1968-72 | 108 | $1.08 | Diked disposal area, cropped |
| Paris West Lake | 1905 | 1972-81 | 284 | NA | Diked disposal area |
| Oakland | 1937 | 1980 | 95 | $0.76 | Diked disposal area |
| Paradise | 1907 | 1980 | 2.3 | NA | Terraced area, cropped |
| Old Pittsfield | 1924 | 1951 | NA | NA | NA |
| Spring Lake-Mahomet | 1956 | 1976-80 | NA | NA | Fill |
| Apple Canyon Lake | 1969 | 1978-79 | 48 | NA | Fill and crops |
| Lake Depue | Natural | 1983 | NA | NA | NA |
| Lake Park-Champaign | NA | NA | 22.3 | NA | Fill |
| Lake of the Woods | 1948 | NA | NA | NA | Fill |
| Crystal Lake-Urbana | 1900 | 1985 | 54.5 | $5.00 | Landfill capping |
| Lake Springfield | 1934 | 1987-89† | 2,700† | $2.96† | Diked disposal area, cropped |

Note: NA = information not available.
* Lake locations are shown in Figure 1.
** Includes disposal costs.
† Estimated and projected.

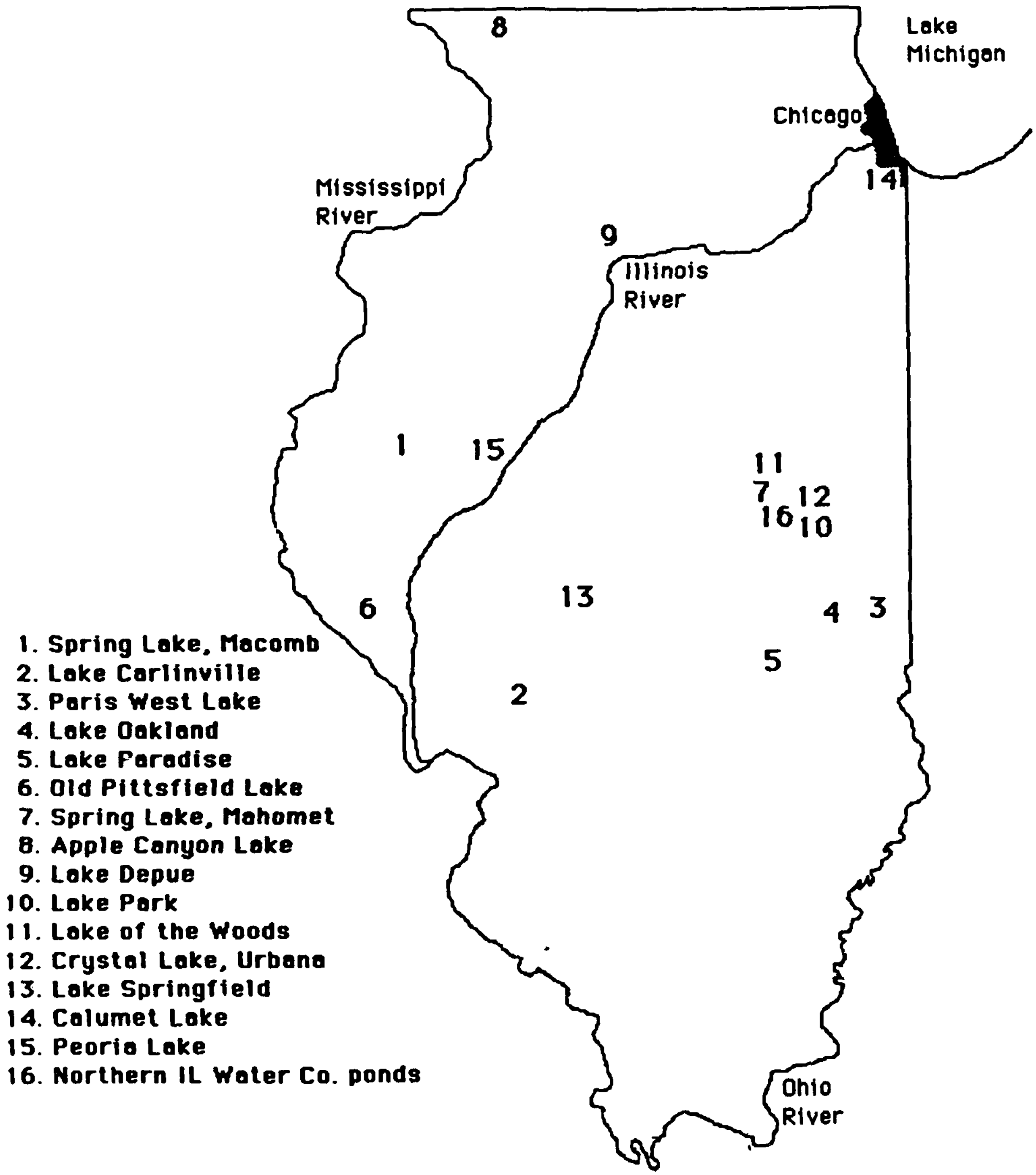


Figure 1. Location map of lake dredging sites in Illinois

## SESSION III: INNOVATIVE BENEFICIAL USES AND CONCEPTS

# THE UPPER MISSISSIPPI RIVER CHANNEL MAINTENANCE PLAN, BENEFICIAL AND PRODUCTIVE USE OF THE DREDGED MATERIAL

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## Background

The St. Paul CE District is responsible for maintaining the northern 244 miles of the Upper Mississippi River 9-ft channel project from Minneapolis, MN, to Guttenburg, IA (Figure 1). In addition to the main stem, 9-ft channels are also authorized on several tributaries which include 14.7 miles on the Minnesota River, 24.5 miles on the St. Croix River, and 1.4 miles on the Black River.

Annual channel maintenance dredging averages 800,000 cu yd at approximately 25 different locations. There are over 100 sites that have required dredging with varying frequency during the life of the project. Individual dredging jobs are quite small and distributed geographically over the project boundaries.

The authorized project depth is 9 ft, but dredging is initiated when shoaling reaches 10.5 ft. Dredging depths range from 11 to 13 ft depending upon various hydraulic factors and operational considerations that influence the effectiveness and efficiency of maintaining the project depth. For the majority of the project, the authorized width is 300 ft with a provision for increased width on bends. The typical commercial vessel using the project is a 15-barge tow configured 3 barges wide by 5 barges long. It is 105 ft wide and with the towboat, a typical tow is 1,200 ft.

The primary equipment used for channel maintenance is the dredge WILLIAM A. THOMPSON, a 20-in. pipeline cutterhead dredge that is operated by the District and part of the nationwide minimum fleet. The THOMPSON is also used by Rock Island and St. Louis CE Districts so that it is only available to the St. Paul District approximately 3 months each year.

In the District's reach, the Mississippi River Valley is carved out some 500-600 ft below the surrounding farmland. Generally, railroad tracks and highways line both sides of the river at the base of the slopes. Small communities also located at the base are spaced along the river at approximately 10-mile intervals. The main channel winds through the floodplain with wetlands on both sides of the river extending to the toe of the bluffs. The environmental setting and physical characteristics combine to make acceptable placement of dredged material a challenge.

## The District's Channel Maintenance Approach

Past channel-maintenance practices caused a great deal of concern for the loss of environmentally valuable wetlands. Of special concern was the cumulative long-term effects of dredged-material placement. This concern resulted in a major study through the Congressionally authorized GREAT study (1974-1980) which brought interested State and Federal resource management agencies together to investigate and recommend solutions to the problems facing the river.

An approach evolved from this study of channel maintenance that has been adopted by the District. It consists of four basic components. The first involves long-range planning for the entire channel maintenance program especially with regard to placement of dredged material. A 40-year planning period was selected, and for each historic dredging location, future dredging quantities for that time frame were projected. Placement-site alternatives were evaluated, and recommendations were made.

Secondly, planning is done in close cooperation with other agencies and the public to assure that all interests are considered and a balanced plan developed. This close coordination is accomplished today through the interagency Channel Maintenance Forum which meets regularly and makes changes to the original recommendations needed so that flexibility is ensured. Another coordination mechanism used is the On-Site Inspection Team, which is an interagency group of field level resource managers that advise the CE on day-to-day activities.

The third element of the District's channel maintenance approach is determining ways of reducing or controlling dredging requirements. This is done by a variety of structural and nonstructural techniques including sediment trap dredging, control structure modifications (wing dams, closing dams, and groins), closer monitoring of channel conditions, and altering dredging dimensions. Although the District has a number of examples and successes with this type of work, they are not fully discussed in this paper due to space and time limitation, and now to concentrate on the beneficial use aspects of the program, the fourth major component of our dredging maintenance approach.

## Beneficial Uses of Dredged Material

If dredging requirements cannot be reduced or controlled, placement planning gives full consideration to beneficial uses of the material. Approximately 95 percent of the dredged material in the St. Paul District is uncontaminated medium-coarse sand. The District has provided dredged material for a variety of uses to other Federal and State agencies, counties, cities, private organizations, and private landowners. If a multiple demand exists and other considerations are equal, material is provided to the entity representing the larger public constituency. The material becomes the property and responsibility of the site owner.

Reads Landing

A good example of how this management approach has been implemented is the Reads Landing project in lower Pool 4 at RM 763.5. The Reads Landing dredge cut, located immediately downstream of the Chippewa River, is considered the most chronic shoaling location in the District. Dredged material has historically been deposited on islands adjacent to the navigation channel. In the 1970's, measures were taken to contain the material on old dredged material, but by the early 1980's the disposal area was filled to capacity. Further expansion was not possible because State and Federal resource agencies would not allow material to spill into adjacent wetlands.

In 1984-1985, as a result of long-term planning and extensive coordination with other agencies and the public, a two-part solution was implemented. Capacity at the historic placement site was restored by excavating 1,300,000 cu yd of material by hydraulic dredging. The material was transferred 9,000 ft to an abandoned gravel pit in Wabasha, MN, that the government had acquired as a long-range placement site. Material placed into the gravel pit restores the area to pre-pit conditions and is available for removal and beneficial use elsewhere. In fact, a contractor working for the Minnesota Department of Transportation is removing nearly 200,000 cu yd at this time for a nearby road improvement project.

By excavating the historic placement site, it can now be efficiently used again when channel maintenance is required. However, the second part of the solution is designed to reduce channel dredging at the minimum control when and where dredging takes place. The Chippewa River is one of the largest contributors of sediment into the Upper Mississippi River system. It deposits large volumes of coarse sand into the navigation channel each year. Shoaling can occur very rapidly and without warning, resulting in restricted or hazardous channel conditions for commercial traffic.

Based on the results of mathematical and physical model studies, a sediment trap was dredged at the delta of the Chippawa River to "catch" the material before it could enter the Mississippi River navigation channel. Approximately 470,000 cu yd was removed from the delta under the same contract as the historic site excavation and transported by pipeline to the same gravel pit.

To date, the sediment trap has been successful in reducing dredging requirements in the main channel. The delta is periodically monitored and will require dredging again in early 1988. If fully successful, this trap will allow the CE to schedule dredging more efficiently and prevent the development of hazardous channel conditions, not only at the Reads Landing dredge cut but also at locations downstream that are affected by sediment depositing from the Chippawa River.

The Reads Landing/Chippawa Delta project incorporates all of the four elements of the District's approach to channel maintenance. It is a long-term plan that has been fully coordinated. It is a plan that allows the CE to have more control over the timing and location of dredging requirements, and yet material that is dredged is ultimately put to a beneficial use.

## Other Major Placement Sites

This same approach is applied throughout the District. At Crats Island in Pool 4, another historic placement site is presently being excavated. That material is being used for reclaiming two privately owned gravel pits which can be developed for commercial or residential purposes. In Pool 5, two placement sites are being excavated and material is being used to restore and enhance the 4,000-acre Weaver Bottoms backwater. This is being done by modifying side channels entering the Weaver Bottoms and constructing islands in the backwater to reduce flows, sedimentation, and turbidity, thus promoting the growth of aquatic vegetation and improving fish and wildlife habitats. The project represents an excellent example of beneficial use of maintenance-dredged material for environmental enhancement purposes.

At Wilds Bend in Pool 5, a placement site was excavated with mechanical equipment, and the material was transported 7 miles to Winona, MN, for use as fill for commercial development. This was made possible through a local cost-sharing agreement which made it economically feasible for both the CE and the community to benefit from the material. Another placement site excavation took place in spring 1987 at Lansing, IA. The material was again provided to the local community. At this site, the material was used as fill for recreation development.

By excavating large quantities from historic placement sites, the District is able to accomplish several objectives. It restores capacity at sites located adjacent to the dredge cuts so that channel maintenance dredging can be efficiently conducted hydraulically without having to transport material long distances. It provides a long-term site that is environmentally acceptable and complies with State and Federal regulations. It also provides an opportunity to plan for beneficial use of the dredged material and takes advantage of local demand for the material.

## Other Beneficial Use Sites Throughout the District

Beneficial use in the St. Paul District is not limited to where major placement sites are excavated. Such use is an integral part of the channel maintenance program that is considered for each dredging event. Examples of beneficial use are:

a. Kinnickinnic State Park. Material was placed at this Wisconsin park for beach creation and recreational site construction.

b. Point Douglas Park. Material was placed at this Washington County, Minnesota, park as fill for recreational development.

c. Kraemer Landfill. Material was stockpiled for use as cover or capping material for a privately operated sanitary landfill.

d. Packer Terminal. A site owned by the city of Minneapolis that is leased to a private terminal operator. The operator manages and disperses the stockpiled dredged material, which is in high demand throughout the metropolitan area for general construction purposes.

e. Pool 1 Site. This stockpile site is owned by the city of Minneapolis, and a special agreement makes the city responsible for assuring that capacity is always available. Stockpiled dredged material is removed by the city for general construction purposes.

f. Pioneer Press. Dredged material was provided as fill to the St. Paul Port Authority. The site has been developed by the St. Paul Pioneer Press newspaper with construction of a large printing plant.

g. St. Paul Airport. A site owned by the Metropolitan Airport Commission is used to stockpile dredged material which is then used as fill for airport expansion projects.

h. Ochsner Site. This is a privately owned residential development site located in Wabasha, MN, where stockpiled dredged material is used as needed for residential construction.

i. Alma Marina. Dredged material has been furnished to the city of Alma, WI, as fill for development of a recreational area. A CE-owned stockpile site at this location also makes material available for removal and general use. Buffalo County, WI, is a primary user for road maintenance and ice control.

j. Lock and Dam 5. A stockpile area was prepared during construction of a loading dock for the lock and dam, and this material is available for general use by anyone who needs it.

k. Gotz Site. This is a privately owned site where dredged material is stockpiled and made available for general use.

l. Winona Levee Site. A local contractor furnished and operated a conveyer system to transfer dredged material over the flood control levee. Material was used for general construction purposes.

m. Lock and Dam 6. A CE-owned stockpile site located here provides dredged material for general construction and other use.

n. Shore Acres. Dredged material was placed in three sunken barges which were installed to provide shoreline protection and stabilization to private landowners.

o. Isle la Plume. This is a stockpiled site owned by the city of LaCrosse, WI, where the material is used for general purposes. The city is required to assure capacity is always available during maintenance dredging.

p. Brownsville. This is a CE-owned stockpile site where material is removed for general use. The community of Brownsville, MN, recently removed 150,000 cu yd for use as fill in construction of a wastewater treatment plant.

q. Lansing Bridge. This stockpile site provides dredged material for general purpose use. The city of Lansing, IA, is the primary user.

r. Village Creek. Dredged material was furnished to the State of Iowa as fill for development of a boat-launching ramp and parking lot.

The above examples represent many of the beneficial uses of dredged material in the St. Paul District. The sites are located throughout the District (Figure 1). Long-range planning is also taking place to evaluate locations where material can be used to enhance recreational beaches along the Mississippi River shoreline.

## Summary

We believe that the District's success in achieving beneficial uses of dredged material is the result of careful, long-range planning and close coordination with other interests. This has been accomplished because the CE realizes that it can be an efficient and effective way of administering the overall dredging program, and it supports this approach with the necessary resources. The planning and coordination are ongoing elements of the dredging program and must have built-in flexibility to make changes and to respond to new or changing conditions. The St. Paul District will continue efforts to maximize the beneficial uses of dredged material within its boundaries.

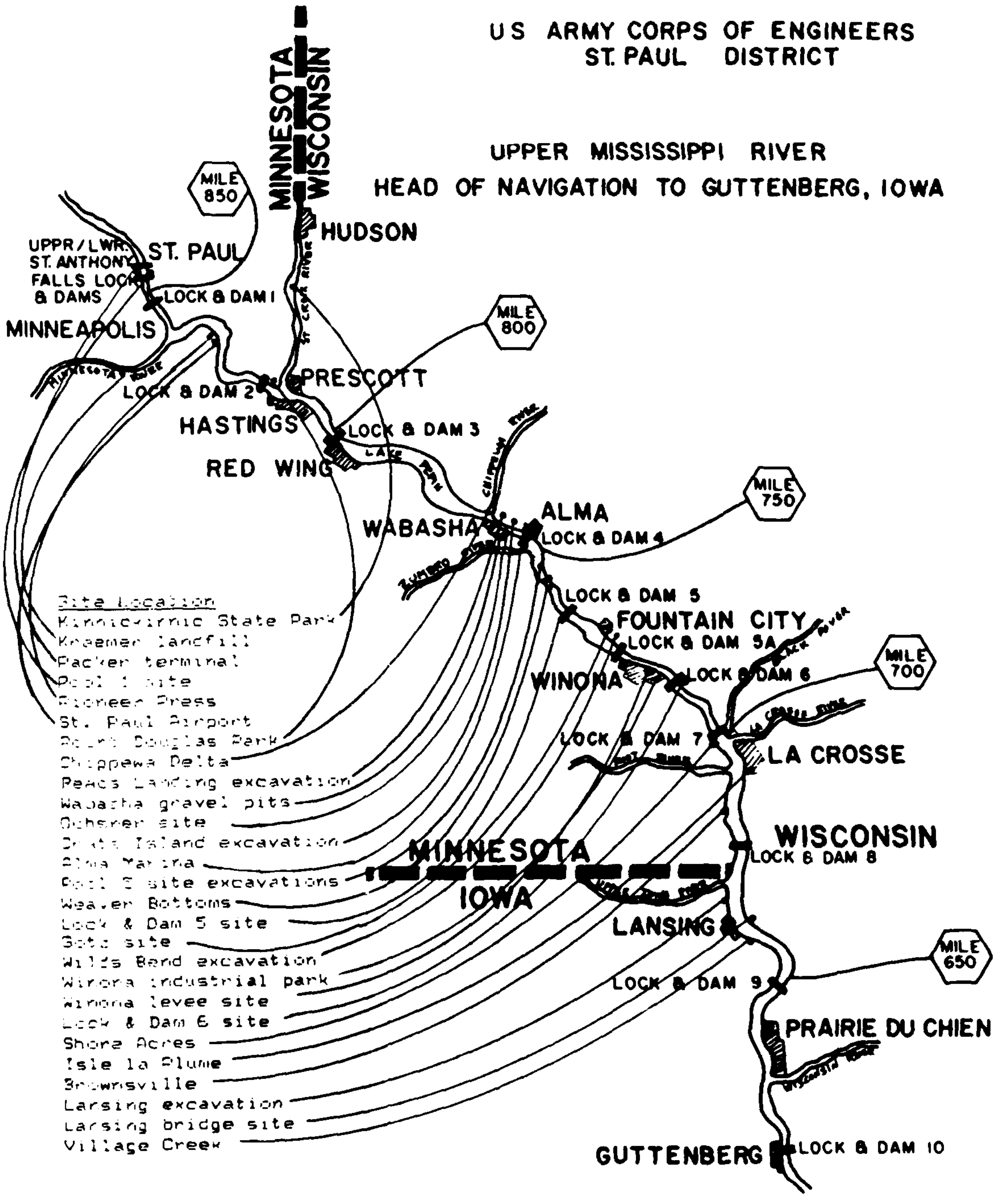


Figure 1. A schematic of the St. Paul CE District channel-maintenance area, including beneficial use sites throughout the District

# SESSION IV: RECREATION, COMMERCIAL, AND INDUSTRIAL BENEFICIAL USES APPLICATIONS

## OPENING REMARKS

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I'd like to welcome you to this technical session, and before I introduce our speakers, I want to pass on to you the information that there will be a regional Northern Gulf Coast Workshop on the beneficial uses of dredged material held in Galveston, TX, on 26-28 April 1988. I want to stress that the workshop will be held on dredged material because this literally is true. The conference hotel, and in fact the entire city of Galveston, is built on several feet of dredged material. We invite you all to come because there are many, many present and potential beneficial uses of dredged material in the gulf coast region.

I have been working for the CE for 30 years---that's a long time. There is another long-timer here that I want to recognize. I have worked in close association with Bill Murden for at least 20 of those years, and I wanted to publicly thank Bill and let him know how much he will be missed. We also still expect him to show up for special occasions such as this.

I want to respond to several questions I have been asked here about the aquaculture demonstration project going on at Brownsville, TX, in a confined disposal facility. There are actually two confined areas, each approximately 120 acres in size. The two confinement areas can be alternated so that two different age crops of shrimp, or even two different crops of different shellfish, can be growing at the same time. So far, we have only used one of the confinement areas.

The first harvests totaled 140,000 lb---if you don't think that is a lot of shrimp, try buying 140,000 lb. That's over 400,000,000 shrimp, and it would cost you a lot of money. Remember, they were grown in less than 1 year inside a 120-acre confined disposal facility.

I have been asked how they are harvested. Well, being from Texas, I could tell you that we put on our hats and boots and drove them into little corrals; however, they were harvested using nets and standard commercial harvest techniques. We invite you to come down and look at the project if you are interested in the great potential for aquaculture inside disposal facilities between dredging cycles.

We have four very interesting papers for you that represent a wide range of beneficial uses of dredged material, as well as a wide cross section of the US from the Pacific Northwest to the Mississippi River to the TTWW. Recreational, commercial, industrial, as well as some agricultural use of dredged material has been carried out for many years. In fact, the first such sites were built prior to the Revolutionary War on the east coast. Even after

250 years, the use of dredged material for such purposes is still highly desirable, especially in densely urbanized areas with limited development space.

## SESSION IV: RECREATIONAL, COMMERCIAL AND INDUSTRIAL BENEFICIAL USE APPLICATIONS

# INNOVATIVE RECREATION AND COMMERCIAL USES OF DREDGED MATERIAL ON THE TENNESSEE-TOMBIGBEE WATERWAY

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The Tennessee-Tombigbee Waterway (TTWW), authorized by Congress in 1946, and opened to navigation traffic in January 1985, is a connecting link joining the well-established Tennessee River and Black Warrior-Tombigbee River Systems. The 234-mile waterway with its 10 locks and dams and 44,000 acres of water surface has the identified purposes of navigation, fish and wildlife conservation, recreation, and area redevelopment. For descriptive purposes, the TTWW is divided into three sections (divide, canal, and river), which generally characterize the project configuration in each section. The disposal concepts utilized for each section were tailored to accommodate the terrain because of the differences in topography and stream characteristics in each of the sections. Design and construction responsibilities were shared between the Nashville CE District (divide section) and the Mobile CE District (canal and river sections).

Initial construction funding for the TTWW was appropriated in 1970, which coincided with the enactment of the National Environmental Policy Act (NEPA). Thus, the TTWW was among the first large water resource projects to be developed under the auspices of NEPA, which heavily influenced the manner in which the waterway was constructed as compared to the conceptual design that existed in 1970.

Among the first steps taken to address the spirit and intent of this brand new and very comprehensive environmental mandate was to establish the following environmental objectives:

a. To preserve unique and important ecological, aesthetic, and cultural values.

b. To conserve and use wisely the natural resources for the benefit of present and future generations.

c. To enhance, maintain, and restore the natural and man-made environment.

d. To create new opportunities to use and enjoy the environment (US Army Corps of Engineers, Mobile District 1971).

Excerpts from a special issue of Journal of Environmental Geology and Water Sciences illustrates the process that was employed to address these objectives (McClure 1985):

"The preliminary analysis indicated that a project of the magnitude and complexity of the Tenn-Tom would require a comprehensive approach in order to comply with the spirit and intent of NEPA. In recognition of this requirement, a continuing environmental studies process was formulated. Three vital components of these studies were the interdisciplinary approach, a structured study design, and the use of outside consultants.

"The use of an interdisciplinary approach involved a melding of the physical, biological, and cultural resource sciences together with the design arts. This added dimension had a considerable influence on the development of the Tenn-Tom. The value of this approach was particularly evident in analyzing alternative design concepts.

"The structure of the Continuing Environmental Studies (CES) was based on a three-phase approach. The first phase involved a general assessment of the environmental impacts and documentation of the identified impacts in an EIS. In preparing the EIS, it was recognized that refinements in the project design would be required to achieve the environmental objectives. Incorporating these objectives into the EIS represented a commitment to make the Tenn-Tom more compatible with the environment.

"The second phase of the CES was launched immediately on completion of the EIS. It consisted of a sustained large-scale effort to delineate the environmental impacts in greater detail and to incorporate measures into the project design in the interest of environmental quality and environmental protection. Detailed studies were conducted in a number of areas and substantial amounts of data were collected and disseminated to the scientific community and made available to the public. The environmental information generated was of extensive value in modifying project design to meet the environmental objectives. Application of the interdisciplinary approach was especially evident in this process. NEPA-related documentation included three supplemental environmental reports (SERs) (US Army 1975, 1984) and a supplement to the EIS (SEIS) (US Army Corps of Engineers, Mobile District 1982). The SERs provide documentation of the environmental studies that were conducted. Some 31 volumes of SERs were issued. The SEIS describes the project with the design modifications incorporated and provides further details of the associated environmental impacts.

"---The Third Phase consists of continuing environmental evaluations at a reduced scale during project construction and will continue throughout operational phases of the waterway. This portion includes post-construction studies on areas investigated during the previous phases, and offers the opportunity of reducing adverse impacts and increasing the beneficial impacts may be presented. Since the construction of Tenn-Tom required almost 15 years, with various project components being completed sequentially, some phase three-type studies have already been conducted."

Another important ingredient in the environmental planning effort was the creation of an interdisciplinary Board of Environmental Consultants. The Board, comprised of three eminently qualified professionals in the field of hydrogeology, ecology, and environmental planning/design arts, met with District staffs on an approximately quarterly basis to discuss environmental studies and analyses, to evaluate alternatives, and to suggest options for

meeting the environmental objectives. The Board played a vital role, providing external overview and fresh insight in the evolutionary design process. Unencumbered by pre-NEPA stereotype thinking, they freely recommended alternative approaches which were then evaluated by the District staffs to determine their viability based on environmental, engineering, and economic considerations.

The EIS which culminated Phase I of the CES recognized that disposal of some 300 MCY of excess material represented a sizable challenge. The EIS stated: "Present plans call for the excavated material to be waste adjacent to the cuts. However, the optimum methods for the final disposal of all this material have not been determined and a significant amount of the total environmental and engineering studies effort will be devoted to this matter." (US Army Corps of Engineers, Mobile District 1971). An interdisciplinary team approach was utilized to site the disposal areas in a manner which avoided to the extent practicable the more valuable wildlife habitats and cultural resources. After siting the disposal areas utilizing false color infrared photography delineating habitat types, field siting efforts with a team of biologists, real estate specialists, and representatives of the FWS were undertaken. The disposal area in the vicinity of the Columbus cutoff near Columbus, MS, graphically illustrates how this approach permitted the avoidance of important resources. The disposal area dike was aligned to preserve an Indian mound and the site was oriented to protect White's Slough, a valuable wetland habitat.

A different disposal method was utilized for each of the three sections of the TTWW. For the divide section, where one-half of the total yardage had to be handled in one-tenth percent of the total waterway length, erosional valleys adjacent to the cut were filled and then contoured and planted to control further erosion. The areas were subsequently planted with vegetation selected to provide wildlife food and habitat. In addition, ponds were incorporated to contain sediment and in the interest of fish and wildlife resources.

In the canal section, the westside levee provided a convenient place for the excavated material while also satisfying functional requirements by retaining water in the canal and preventing flooding from the river. The levee was overbuilt in most areas where excess material existed. The levee was planted to control erosion and promote revegetation. Diked disposal sites were provided to contain a small portion of the excess construction material and to accommodate maintenance material.

In the river section, the majority of the excavation was accomplished by hydraulic dredging, necessitating a special type disposal approach. A two-celled diked disposal design was utilized to contain the material and to control turbidity in the return water. Buffer strips were provided to screen the sites from the river and surrounding lands and to protect adjacent resources. In addition to functioning as an ecotone surrounding the disposal sites, the buffers served as a seed source to promote revegetation of the sites. Natural revegetation has been very successful in returning the sites to productive wildlife habitat.

Throughout the process of locating disposal sites, the concept of beneficial use of the excavated material was a prime consideration. A number of opportunities were identified and pursued. Table 1 lists the disposal areas that have been or are proposed for use as ports or industrial sites. In two instances, the ports of Columbus and Amory, MS, were public entities that allowed the CE to dispose on their lands in order to create situations suitable for development. In other instances, disposal area lands were acquired by public entities under the provisions of Section 108 of PL 86-645, which authorizes disposition of property for the purpose of developing or encouraging the development of public port or industrial facilities.

As previously stated, recreation is a recognized purpose for the TTWW. The development of recreation facilities promotes the fulfillment of the objective of encouraging the utilization and enjoyment of the waterway's environment by the public. The creation of disposal areas offered opportunities for the incorporation of these sites into recreation areas. As noted in Table 2, advantage was taken of the availability of these sites, primarily because of their elevation above the floodplain.

A special beneficial application of dredged material has occurred in the river section. Thirty-five bendways, the portion of the river severed by a cutoff, were created in the river section. This left some 71 miles of the old river essentially undisturbed except for increased water-surface elevations associated with impoundments. The bendways provide valuable aquatic habitat away from the navigation channel but are subject to accelerated sedimentation during floods (US Army Corps of Engineers, Mobile District 1984). Special measures have been taken to protect this resource and prolong the useful life. Blockage structures have been placed across the upstream end of several bendways utilizing dredged maintenance material to create the blockage. These top-of-bank structures preclude the bedload and heavier suspended sediment from entering the bendway for floods below the top-of-bank. Utilization of maintenance material for this beneficial purpose also has the collateral advantage of conserving the capacity of the existing disposal areas for future maintenance disposal.

Another bendway management measure involves the dredging of the upstream end of the bendway to remove accumulated sediment. The dredged material can be placed in existing disposal areas; however, an approach that has proved to provide secondary benefits has been the reshaping of the entrance conditions with dredged material. While the primary purpose of the reconfiguration is to direct the movement of sediment away from the bendway entrance, the creation of a beach has allowed the realization of recreational usage similar to that experienced at large sandbars. The beach-like area has proved popular for boating, swimming, sunbathing, and other beach-associated activities.

Preservation of a significant prehistoric Indian ceremonial center at the Lubbub Creek Cutoff in Gainesville Lake (river section) also incorporated an innovative beneficial use of dredged material. The cultural site, located on the island created by the cutoff, required protection to prevent erosional processes from threatening the integrity of the site. In this case, dredged material was placed on the cultural site like a protective blanket so that construction equipment could move over the site without causing damage. The protective dredged material layer was left in place and continues to provide

protection for the site. The disposal site originally proposed for the area was relocated across the cutoff. The riprap protection that was provided not only protects the site but also prevents sloughing into the channel.

Most of the disposal areas are being managed as wildlife habitats as partial mitigation for the resource losses that resulted from waterway development (US Army Corps of Engineer, Mobile District 1983). A companion presentation at this workshop by Danny Hartley describes in detail ongoing management measures for wildlife and waterfowl conservation, and this paper will not discuss that aspect of the TTWW.

In the divide section, an experimental approach was tested utilizing a dredge to remove a portion of the material just south of the State Highway 25 bridge at the upper end of the divide cut. A series of containment and settlement ponds were constructed to hold the material and protect water quality. Upon completion of the tests, the water level control weirs and stoplogs were left in place. These are manipulated to regulate the water levels so that the disposal ponds function as waterfowl subimpoundments.

Overall, the disposal concepts for the TTWW have been successful in the accommodation of massive quantities of construction material and in the provision of 50 years' maintenance capacity. A number of innovative beneficial uses have been incorporated in efforts to utilize the excavated material and the disposal areas as resources as opposed to a wasted material. Even with all these efforts, the disposal activities still caused adverse impacts, especially in the loss of wildlife habitat. In conformance with the mitigation provisions of NEPA, compensations for losses of significant resources were recommended by the District.

In November 1986, Congress passed the WRDA which in Section 601 authorizes the acquisition and intensive management of 88,000 acres of separable lands. These are to replace the lost and altered habitats resulting from waterway development, including the establishment of disposal areas which affected 14,248 acres (McLindon 1985).

The interdisciplinary CES process was effective in achieving the environmental objectives established for the TTWW. While the future may offer additional opportunities for beneficial use of excavated material, for example, mining of sand and gravel for commercial uses, the accomplishments to date have been significant. The experiences gained on the TTWW provide important lessons for the successful handling of large quantities of excavated material in an environmentally acceptable manner.

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Table 1

Use of Dredged Material for Ports and Industrial Areas

| Location | Remarks |
|---|---|
| Divide | |
| Yellow Creek Port | Embayment filled for future industrial expansion. |
| Paden | Proposed bulk handling port facility would utilize dredged material. |
| Canal | |
| Fulton | Disposal area utilized for city public port and for private wood chipping and loading operation. |
| Amory | Disposal area utilized for Itawamba-Lee County industrial port complex. |
| River | |
| Columbus | Disposal area utilized for Columbus-Lowndes County River Port and Industrial Park. Site is on bendway and CE provided channel under Section 107, PL 86-645. |
| Aliceville | Disposal area utilized for portion of Bevill-Hook Port and Industrial Park. Port constructed by CE for Appalachian Regional Commission. Dredged material utilized to raise site above 100-yr floodplain. |

Table 2

Recreational Uses of Dredged Material

| Location | Remarks |
|---|---|
| **Divide** | |
| All disposal areas | Disposal areas are managed for wildlife and to support hunting opportunities. |
| **River** | |
| Aberdeen Lake-Blue Bluff Recreation Area (RA) | Disposal area will be utilized for resort type development (marina, parking, restaurant, and golf course). |
| Columbus Lake-Town Creek RA | Disposal area will support bicycle trail in association with adjacent campground. |
| Aliceville Lake-Columbus RA | Disposal area used by bicycle-running trail and wildlife viewing area. |
| Aliceville Lake-Luxapalila Creek RA | Disposal mound from flood control project utilized for road and parking area. |
| Aliceville Lake-Pickensville RA | Dredged material from marina utilized as fill for parking area and boat launching ramp. Disposal area was contoured to provide for site drainage and aesthetics. |

QUESTION: In large-tract acquisitions such as the TTWW, do you think you have that many willing sellers of land? What is the prospect in your view of being able to purchase this type of mitigation land from willing sellers?

MR. McCLURE: We have already gotten that settled. We have already identified more than enough acreage owned by people who have indicated willingness to sell to us for mitigation land.

QUESTION: You mentioned a visitor's center in your talk. Was it built as a visitor's center or for some other purpose first?

MR. McCLURE: It was built as a visitor's center.

# SESSION IV: RECREATION, COMMERCIAL, AND INDUSTRIAL BENEFICIAL USE APPLICATIONS

## COMMERCIAL AND INDUSTRIAL USES OF DREDGED MATERIAL IN THE MEMPHIS AREA OF THE LOWER MISSISSIPPI RIVER

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Well, I have listened to a number of good speakers over the past 2 days, and they have one by one made every point I was going to make in my talk, so I don't think I will go through them again. Rather, I want to talk about some improvements in the beneficial use concept that we have not yet discussed. The primary factor I have noticed missing in any reference to inland waterway ports and cities is the need for consideration of the character of the city, the planning of the city, the nature of its people, as these things affect the city's attitude toward the waterway. And of course, it affects its attitude toward dredging and the potential beneficial use of the dredged material. River cities have destinies, and I will talk about that later because those destinies are the controlling factor regarding those cities whether it be land use, dredging, or whatever.

I want to talk a bit about the obligation of the beneficiaries of the dredged material around cities and the obligation of the Federal government. These are two different things. Let me use Memphis as an example. We have 58 miles of river bluff and slack water frontage. That is a lot of miles; however, I have found out that New York City has 580 miles of river front, so we only have 10 percent as much as they!

When Memphis was founded in 1819, it was built on one of the Chickasaw Bluffs, which was the only high, flood-free land adjacent to the river and the massive lower Mississippi River alluvial valley. Near Memphis, our river floodplain is at least 30 miles wide. It gets wider as the river moves toward the Gulf of Mexico. Helena, AR, and Vicksburg and Natchez, MS, are the only other bluff cities on the Lower Mississippi River, and there's a lot of floodplain between those bluff situations.

Prior to the 1950's, almost all commerce in and out of these bluff cities, including Memphis, moved by water. By the 1950's, the city had begun to change character in relation to the river, and the bustling old cobblestoned riverfront changed in favor of other types of urban development and other ways of moving goods in and out of the city. Nonriver interests are taking over the riverfront, including financial institutions, government buildings, residences, other businesses---everything but the waterway-related transportation and the industry that goes with it. In Memphis, the competition is very keen from many sources for the city objectives and goals that let the city grow. The city administrators must listen to all sides even though they realize the importance of our river. However, the city fathers are not going to let the waterways transportation and its accompanying

industries have all the manpower, all the money, all the resources that they once did. It makes our job of developing, maintaining, and improving our Port of Memphis even more critical because we have to meet the competition from all comers.

Don McCrory has already told you in an earlier paper something about the history of beneficial uses of dredged material around Memphis and given you examples of publicly owned President's Island industrial development, wetlands, agriculture, forestry, and natural resource use; privately owned Mud Island and its developed recreational potential; privately owned agricultural enhancement at West Memphis, AR, across the river from President's Island; and other beneficial use sites around Memphis. I will mention a few things about President's Island port. The entire complex was built of dredged material, and the dredging was done for navigation on the river. The mouth of the harbor has to be dredged regularly to keep it from silting, and each dredging cycle usually generates about 300,000 cu yd. We put that material in managed sites on President's Island and intend to put it to use as soon as possible. In the meantime, the wildlife and fisheries use on the undeveloped part of our complex, including the disposal sites, is tremendous. Don has already told you about the problems the port has with illegal hunters and trespassers.

There is also some maintenance dredging taking place at the mouth of Nonconnah Creek, one of three creeks that flow through the city of Memphis and into the Mississippi River. Nonconnah Creek was channelized over 50 years ago and as a result had stabilized until about 15 to 20 years ago when every developer in town, it seems, started to build alongside the creek and started severe erosion problems. All of this sediment runs into McKellar Lake, which is part of the harbor, and when we have to dredge it out, it amounts to about 200,000 cu yd each time. Some of it is gravel, and it has been utilized by industry. Some of the material is placed on the port site, and some on the Treasure Island site, which is being used to develop an industrial port by a private landowner. So far, both the Port of Memphis and the private industry port are doing well, and we are certainly putting all that dredged material to good use!

Now that I have mentioned several of our beneficial use sites around Memphis, I want to talk about a few statistics of development. Mud Island is 350 acres and is privately owned and developed. The same people owned it before dredging that own it now, and the property values as a result of the dredging operations have skyrocketed. The land is worth upward of $2.00/sq ft at current downtown land prices.

President's Island is about 1,000 acres and has been publicly owned both before and after dredging. Its current land value, both the undeveloped and the developed portions of it, is worth about $1.00/sq ft. Before dredging, it was only floodplain agricultural land valued at much less. So you can see that by virtue of the placement of dredged material on the site and raising it above flood stage, the value has increased dramatically. This is true of about 300 publicly owned acres near the harbor entrance that we are building now at the rate of about 300,000 cu yd/year, and the same is also true of two other privately owned sites, one 400 acres and the other on Treasure Island about 750 acres, that are being filled now with maintenance material.

In the Memphis area, it takes about 45,000 cu yd to bring 1 acre of managed area up above the 100-year flood level, so it takes quite a while to build a sizable parcel of land. However, the land improvements we have already made have increased the value of the land over $126,000,000. This dredging has only cost the taxpayers about $1.00/cu yd.

Let me cover the course of development of a typical city on a river. Roy A. Mann published a book about 20 years ago in which he evaluated the growth of 18 cites in Europe and 2 in the US. He came to the conclusion that there are four stages of development: (a) a fishing village; (b) a small diversified town; (c) a river-oriented, expanding city; and (d) a larger, more comprehensive city. Memphis is in the third stage right now and working toward the fourth. A comprehensive city would want to plan its waterfront for a variety of uses. We are starting to do that now in Memphis, and that is not something I have heard much about at this conference. Speakers talk about industrial beneficial use on the one hand and recreational beneficial use on the other, but they haven't combined the two to look at the big picture. A total, multipurpose waterway plan is what has to be developed in cities---Louisville, KY, St. Louis, MO, Memphis---one by one, each city of all sizes up and down the inland waterway system of the US is doing the same thing.

Since I am running over my speaking time, I will skip Federal and local sponsor obligations, and I will wrap up by saying that it is a shame when the beneficiaries of the project who are gaining the increases in land values turn out to be private landowners rather than the public. Even with cost-sharing under the WRDA, we are spending taxpayers' dollars to do the dredging and the flood control; the taxpayers are the ones who should benefit not private landowners. Cities and towns along the inland waterways where navigation and flood control are necessary should keep that in mind and demand that the benefits from that work go to the public rather than to private owners. The CE should keep this in mind when it plans its dredging and dredged material management operations and its flood control work.

## SESSION IV: RECREATION, COMMERCIAL, AND INDUSTRIAL BENEFICIAL USE APPLICATIONS

# DEVELOPMENT OF PROJECT LANDS FOR PORT AND INDUSTRIAL USE WITH REGARD TO WILDLIFE MITIGATION

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Thank you for the opportunity to relate to you our dredging program in Walla Walla District. While I have been listening to papers over the past 2 days, two things have jumped out at me. The first is that there has been more than a century of progress on the St. Paul CE District as noted on their sign in the back of the room. One hundred years is more than twice as old as our District, and the progress that has been made on interagency relationships and dredged material placement planning is far ahead of us because of the very short period of time that Walla Walla has been involved in dredging and its accompanying challenge. However, we have made progress, especially in the past 2 years, and we are catching up with the rest of the world.

The second fact that jumped out at me is the relative ease with which you all can establish vegetation and habitats following dredged material placement. We work in an area with 6 to 12 in. of annual precipitation, short growing seasons, and relatively shallow soils. That makes a lot of difference.

I want to relate to you a beneficial use example in Walla Walla District where we had a sedimentation problem in one of our reservoirs, the Lower Granite, which created a need for dredging. Disposal of the dredged material on a wildlife management site and the subsequent interest in that site by all parties concerned is the beginning of the story. First, let me give you some background information.

The Columbia River and Snake River system is one of many navigable waterways in the US. It provides slack water navigation for approximately 500 miles from the Pacific Ocean to Lewiston, ID. There is a series of eight locks and dams, four of which are on the Columbia and four on the Snake. The waterway is managed by both the Portland and Walla Walla CE Districts. Walla Walla provides navigation and flood control. The dams are run-of-the-river locks and dams, each providing about 100 ft of lift, and they also provide significant quantities of hydroelectric power.

Steepness of terrain increases as you go upstream. The two rivers support many activities, including a number of port facilities, commercial trade, recreation, and historic and scenic values. Fertilizer and fuel are barged upstream, and grain and lumber are barged downstream. We don't have nearly the number of barges you support in the Mississippi system due to the character of the rivers and the size of the locks.

We have many water sport participants, and we have quite a bit of habitats, but the steep banks don't allow room for much riparian habitat. Boating is another recreational use, and we have a considerable number of sailboats and wind surfers.

Fishing is a common sport on both rivers with resident species of sturgeon, channel catfish, and smallmouth bass being year-round catches. Most heavily fished, however, are the migratory salmonids, which will play a major part in the rest of my talk. Most abundant species we see are the steelheads and chinooks. There is very high public interest by State and Federal resource agencies in these species and their migration runs. There are also high economic and cultural interests. The Lower Snake River Fish and Wildlife Compensation Plan was authorized by the WRDA. An important part of that law has authorized approximately $200,000,000 for the Compensation Plan for salmonid work.

On the wildlife side, there were approximately 14,000 acres inundated by the locks and dams in the Walla Walla District. We also have a project habitat development program that includes acquisition of 24,000 acres of land for wildlife and for recreational access. This program has only begun, and we currently are short of the funds that would let us proceed faster. We do have numerous willing sellers but no funds to acquire their land.

The program includes a game bird stocking project, and the overall estimated cost is approximately $3,000,000 but is currently unfunded. We also have a resident trout program which involves annual stocking of rainbow trout throughout the southeast Washington State area. These trout are raised in Compensation Plan hatcheries.

There are 10 intensively managed wildlife sites along the Lower Snake. We have used some of these as disposal areas, and several have habitat development on them as mitigation. This includes artificial quail roosts, fences, food plots, irrigation, and watering ponds. Without water, you get dry prairie grasses and very little diversity or wildlife use. We can only irrigate 700 of the 3,000 acres in the 10 sites, but we have had some excellent results on these sites.

The other place we have restored here is the dredged material that resulted from removing the reservoir sediment. The Lower Granite Reservoir at Clarkston and Lewiston has both the Clearwater and the Snake Rivers entering it. We have shoaling and sedimentation problems in other reservoirs but nothing on the magnitude of this one. Eighty percent of the sediment comes from the Snake River and from forestry and agricultural practices and natural erosion.

We do have a water quality problem in that a paper mill at Lewiston, ID, discharges into the reservoir. There is a noticeable dark streak all the way across the reservoir from the mill. This mill intrigues me---it is in Idaho, but it runs its effluent pipe down the length of the river through the reservoir until it discharges across the Washington State line. I have wondered if this was done on purpose.

If there is nothing done to correct shoals and sedimentation in this reservoir, hydrologists predict that all three ports here will be closed off. The dam was built in 1974, and between 1975 and 1982, no one was aware of the problem. Then in 1983 it was noticed; in 1984 it became worse, and by 1985 it was critical. We had to dredge to relieve the problem. We now have to dredge 800,000 cu yd annually to keep sediment out of the port facilities.

There is also the problem with flood control. There are levees all around the city of Lewiston where the river is actually several feet higher than the city. The levees were constructed to have 5 ft of freeboard in a standard project flood. Because of sedimentation, the freeboard has been decreasing proportionally over the years. Without maintenance dredging, the freeboard had decreased to 1.5 ft by 1986. By the year 2000, the city would go underwater with every flood event.

So, where do we put the material we dredge? We have very few upland disposal sites due to the steepness of the terrain. We are trying to find upland sites due to the sensitive nature of the salmonid river use. Unlike many of the discussions I have heard in the last two days, our deposition of clean sand in the water would have the rifles out in a hurry! There is extreme opposition to shallow-water and in-water disposal. We are looking at the potential, feasibility, and impacts of putting the dredged material in deep-water areas and using it for creation of shallow-water habitats. However, the resource agencies are suspicious of our intentions.

We are in the infant stages of dealing with our dredging problems through coordination and communication. It is a painful process that you here in the Upper Mississippi River have already gone through. We have to go through the studies and evaluations and more studies and meetings and shouting matches until we all agree on what is best for the resources, the ports, and the public.

Another problem we are working with now involves a dredged material placement site which is actually the Wilma Habitat Management Unit downstream from the area we are dredging in the Lower Granite. It was a relatively non-productive area, and we have reclaimed it by contouring, using irrigation, and by intensive management as a wildlife area since we placed dredged material here in 1986. We had removed the topsoil prior to dredging and replaced it on the site.

We dredge in January and February during our fish window between adults moving upstream and smolts moving downstream. There actually is an adult steelhead run during this time, but it was the window with the least possible impact. I haven't heard anyone else here talking about having to deal with a fish window. We actually were supposed to be moving 800,000 cu yd, but what wound up being placed on the site was 475,000 cu yd. We are looking to replace the short-term loss of habitat which we anticipate will be just a few years until reestablishment.

Our interagency team of Washington Department of Wildlife, the FWS, and the CE used HEP for determining habitat values prior to dredging. The closest site for interim mitigation we could find is in the next reservoir at a place

called Rice Bar, a moderate use wildlife site. We are developing this site intensively for interim mitigation and are putting in an irrigation system.

About the same time this was happening, the Port of Lewiston decided that this flat, sandy disposal site would make a terrific port expansion site. I have to agree with them---it would. They came to the District and requested that the CE sell the site to the port for development. To do this, we told the port that they would have to acquire mitigation land to replace the site. The site selected for trade is downstream but similar in habitat. It also is 750 acres while the Wilma habitat site is only 171 acres. The habitat trade-off is a good one. However, costs are very different. The port has expedited the trade through their Congressional delegation, and a bill in Congress is helping move things along. However, the bill calls for an even trade and does not mention the difference in land costs. The Wilma site is worth twice as much in dollar value as the 750-acre trade site due to the steep terrain and the lack of developed features at the trade site. We are concerned about the swap. We will lose a lot of habitat at Wilma, including our irrigation system. There are also two archaeological sites that will have to be examined and possibly mitigated, and an EIS has to be approved for the swap.

To recap, Walla Walla District had a couple of large sedimentation events which caused a need for dredging in the Lower Granite Reservoir. The disposal of large amounts of sediment on a wildlife management area made the site very attractive to a local port. Their request for the property has raised concerns over fish and wildlife habitat losses and cultural resources. I believe that, over all, the fish habitat loss will be of greatest concern to the public.

## SESSION IV: RECREATION, COMMERCIAL, AND INDUSTRIAL BENEFICIAL USE APPLICATIONS

# AN OVERVIEW OF DREDGED MATERIAL MANAGEMENT IN THE VICKSBURG DISTRICT

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## Introduction

The Vicksburg CE District encompasses approximately 68,000 square miles of land and water resources within the geographic area of northern Louisiana, southern Arkansas, and western Mississippi. Within this area, the District is responsible for maintaining navigation depths on approximately 950 miles of navigable waterways and assuring that floodflow-carrying capacities are maintained in an additional 2,600 miles of natural and man-made channels. In carrying out these assigned responsibilities, the Vicksburg District either moves or regulates the movement of 20 to 30 MCY of dredged material on an average annual basis.

Prior to the 1970's, the normal procedures for disposing of the dredged material was overboard, or open water, disposal for navigation dredging and random placement adjacent to the channel for flood-control work. These procedures provided the most economical means of handling the material, and the body of environmental law had not progressed to the point of requiring impact assessment of long-term management of the vast volume of material generated by the CE construction and maintenance programs in this way.

Even before the environmental conscience of the US was stirred, there were examples of beneficial uses of dredged material in our District. The harbor at Vicksburg, for example, was developed on dredged material and expanded with hydraulic fill from maintenance dredging. The latest expansion of the harbor was undertaken by the Port Commission utilizing material from the newly excavated channel and from CE maintenance dredging in the Yazoo River.

On a number of our flood control channels constructed in the 1920's and 1930's, there is no evidence of dredged material mounds today. The material has been used by adjacent property owners to fill and level their agricultural land. By today's standards, we might cringe at the thought of identifying this practice as a beneficial use since much of the filling was needed to convert swampland to agricultural use. However, by the standards of time and in view of the levee districts and farmers, the material could not have been put to a better use.

As always, our engineering and construction practices are evaluated in light of current standards, so we find ourselves here to discuss beneficial uses of dredged material as if it were some new concept and as if, by implication, all past practices were of no benefit. In reality, we should recognize that only the standards have changed, and we must now exercise the creativity

and innovation required for our practices to keep pace with the current principles and standards of our various professions.

I have selected a few examples of projects within the Vicksburg District to illustrate the potential uses of dredged material for commercial, industrial, and recreational purposes.

## Wild Cow Bayou Project

As a part of the Tensas-Cocodrie Pumping Plant project in Concordia Parish, LA, channel enlargement was required in Wild Cow Bayou, a natural meander loop of Bayou Cocodrie, to convey water from Bayou Cocodrie to the pumping plant located in the east bank levee of the Black River. The south bank of Wild Cow Bayou was forested at the time of construction while the north bank was in agricultural use. For environmental reasons, it was determined that the enlargement would be done on the north side of the channel with the dredged material to be deposited in open agricultural land. The local sponsor of the project was to provide all project lands and rights-of-way with the channel enlargement rights-of-way to be acquired through construction easements rather than in fee title.

When the landowner refused to grant such easements because of the acreage that would be taken out of production, the District began to pursue an alternate disposal plan that would allow the landowner to reclaim use of the land once the channel enlargement was completed. The plan called for the dredged material to be shaped into a discontinuous embankment with gaps every 500 ft and at all natural drains. Additional rights-of-way would have been acquired in order to limit the height of the embankment and accommodate a 1:20 landside slope. The plan also included reforestation of the riverside slope and batture area. This plan was never fully implemented because of the additional costs involved. It represented a deviation from District policy on project-related costs and real estate requirements.

The landowner eventually granted the necessary easements to complete the work, and the final dredged material configuration was a broad embankment with a 1:3 channelside slope up to a height of 10 ft, then a 1:20 slope up another 10 ft, and on the other side down at a 1:4 slope to natural ground. The landowner was able to farm the top and landside slopes of these mounds without any difficulty. A recent aerial inspection of the project revealed that the dredged material is being fully utilized in agricultural production.

## Tensas River Project

The concept that was not fully implemented on the Wild Cow Bayou project has been dusted off and given a new title for one of the District's current projects on the Tensas River. The concept is now labeled "The Greenbelt Concept" and the environmental benefits of the concept are being more fully exploited in promoting the idea. There are also valid claims for long-term economic benefits associated with the plan in that making use of the dredged

material and rights-of-way to reduce sheet erosion and improve bank stability will reduce future maintenance requirements. It is estimated that erosion along some 300,000 miles of streambanks in the US is depositing roughly 500,000,000 tons of sediment into those streams each year. The cost of removing sediments that eventually choke stream channels and reservoirs is estimated at millions of dollars annually.

On the Tensas River project, the District proposes to acquire rights-of-way on both sides of the channel in order to establish or preserve vegetated buffer strips. The channel enlargement would be accomplished on one side only with a 100-ft-wide buffer zone being established on the side opposite the cut and a 200-ft-wide buffer on the disturbed side. Within the 200-ft buffer, the dredged material would be placed in discontinuous embankments having 1:5 side slopes. The 1:5 slopes are considered critical to the success of efforts to reforest the dredged material and maintain the stability of the embankment. The embankment will intercept sheet flow and divert it to breaks in the embankment at natural drains and tributaries of the Tensas River. The majority of these natural drains and tributaries is very shallow and supports woody and herbaceous vegetation that will serve to filter the runoff. Planting and volunteer revegetation of the embankment will prevent erosion of the dredged-material bank into the channel.

From the environmental standpoint, the concept has obvious benefits in reducing turbidity and the introduction of agri-chemicals or other pollutants into the stream. The vegetated buffers would serve to improve water temperature, water quality, and fisheries resources, would serve as a limited wildlife corridor along the stream, and would dramatically improve the aesthetic values of the river. The fate of the proposed "greenbelt concept" is as yet undetermined because of policy considerations on costs, and because there is no local sponsor for the project which will have to be cost-shared.

## Port Development Examples

The District has also been able to work with local governments and private industry to make beneficial use of material generated by construction and maintenance dredging in the area of port development. During the excavation of the Phillip Bayou Cutoff on the Red River Waterway in Louisiana, the city of Alexandria provided land and containment facilities to utilize a major portion of the excavated material for the development of city/port facilities. Alexandria is presently proceeding with port development.

On the Mississippi River at Lake Providence, LA, an existing harbor facility has been expanded and additional expansions are proposed. These will utilize material from maintenance dredging at the harbor entrance. The port commission has land and containment facilities prepared for the expansion when suitable materials are available.

A similar proposal by Natchitoches Parish officials in Louisiana on the Red River pointed out one problem that must be overcome in order to expand this potential for beneficial use. The Parish officials did not approach the District with their proposal for port development until the procurement

process was underway on that item of work, and their plans were not sufficiently developed to the point where they could be incorporated into the procurement without significant delays in the construction contract. If the public was made aware of the huge volumes of material available for use, the constraints on obtaining use of the material, and the need for early requests and early involvement in the planning process at the beginning stages of a project, I believe more creative uses for the dredged material within Vicksburg District would be developed by the public and by adjacent property owners. We would all have time to consider possibilities and to work out ways to accommodate those possibilities within cost, environmental, and time constraints.

## In Stream Disposal

In some instances, our past practices of disposing of dredged material or utilizing stream-control measures to reduce the volume of material to be moved have resulted in benefits that were not envisioned by the planners and design engineers. For example, on the Ouachita River in Louisiana, we have sidecast sand along the bankline for years, and this method is still used with the blessings of the various State and Federal agencies who review our plans. As a result of our maintenance-dredging techniques, a number of beaches have been developed that receive heavy recreational use.

On the lower Pearl River, similar procedures were used in the 1960's before maintenance of the project was abandoned. Responsibility for the Pearl River Basin was transferred to the Vicksburg District several years ago, and in 1985 we began investigations on the feasibility of resuming maintenance dredging. We found that the natural and man-made bars were providing nesting habitat for the endangered ringed sawback turtle. In the final analysis of this project, we found that by using the dredged material to enlarge the bars, we could complete the maintenance dredging without impacting the species and, in fact, would provide additional nesting habitat that would benefit the recovery of the species. Some of these bars are also receiving heavy recreational use.

On the Mississippi River, our in-water engineering structures, or dike fields, were designed to reduce the volume of dredged material to be removed from the river by constricting the channel and keeping the velocity high enough to prevent deposition in the channel. These dike fields fill with sediment naturally during high river stages. During low stages, the vast sandbars created in the dike fields have provided most of the nesting habitats for the endangered interior least tern. Annual surveys are being conducted to identify current nesting areas, and all dredging permits are conditioned to eliminate interference with active nesting sites.

## Summary

In the past, we have conducted our construction and maintenance dredging programs in a manner consistent with applicable legislation. Discharge sites were selected by comparing alternatives and identifying the least damaging practicable alternative. In the mid-1970's, we initiated construction dredging on the Yazoo River as part of the authorized flood control project for the Yazoo Basin. At that time, the Federal Water Pollution Control Act amendments of 1972 and its implementing regulations and subsequent litigation, as well as Executive Order 11990, indicated that Federal projects should avoid destruction of wetlands in favor of other alternatives. The first items of work on what was identified as the Upper Yazoo Project included disposal areas in agricultural lands on the landside of the levees rather than nearer wetlands on the riverside of the levee. Some of the areas were reclaimed by the landowners for agriculture while others remain as diked containment areas which have revegetated and now possibly provide some wildlife habitat value.

In late 1976, a memorandum from the Council on Environmental Quality to all agency heads interpreted Section 101(b)(4) of NEPA to require that adverse impacts of projects on "prime and unique farmland" be fully addressed in environmental documentation on all Federal projects. Thus, on some later items of work in the Yazoo Basin, dredged material was pumped even greater distances to upland forested areas.

I point this out only to say that in the Lower Mississippi River Valley (and I assume in other parts of the US as well), our selection of disposal sites is becoming more and more restricted with the passage of each new piece of legislation and each new addition to the endangered species list. These restrictions provide a challenge that can be met through innovation and creative plan formulation, design, and implementation. However, many agency philosophies and policies will have to be reshaped in order to promote full development of the concept of beneficial uses of dredged material in the Lower Mississippi Valley inland waterways.

QUESTION: When you are negotiating rights-of-way, do you usually have to pay the landowners?

MR. McGREGOR: On flood control projects, rights-of-way are the responsibility of the local landowners and the land reverts back to them as soon as the flood control work is completed. Levee Boards or other sponsors usually obtain the rights-of-way easements from these landowners, and there is usually a fee paid to the landowners for the right to use the property. The CE is not usually involved in obtaining rights-of-way---the local sponsor is supposed to do this.

COMMENT: We have a project in Ohio where after we are done with the project, we go back in and seed and vegetate the levee and borrow areas for wildlife. Is this similar to what you do in Vicksburg?

MR. McGREGOR: We generally seed the levee slopes to prevent slope erosion, but it's not done with wildlife use in mind because the land reverts back to the landowners, and they usually graze livestock on the slopes.

What you do in Ohio is what we envision for the Tensas River project where we want to establish bottomland hardwood buffer zones on both banks of the river after flood-control work is finished. This is not a new concept, and it still may not happen---the project is in limbo because we have no local sponsor. No local sponsor for the flood-control work has come forward even if the District foots the entire bill for the greenbelt.

We have a streambank erosion-control demonstration project, the Section 32 Project, where we use various types of stabilization techniques to assist local landowners. This is not work the CE normally does but is more in line with the USDA Extension Service. However, we have tried hay bales, fences, gabions, rubber tires, and riprap. It is nice to hear that riprap is so good for aquatic habitats, because that is about all we have found that will work consistently on banks in alluvial delta soils. We have planted willows in tires strapped on the banks and found that if the tires would stay in place long enough for the willows to take root, the technique works well. We have found that we don't even need the tires if the willows can just stay in place against currents and floods until they are established.

QUESTION: How do you handle permit responsibilities when you ask a local sponsor to provide you with a disposal or work site? Does the sponsor have to handle the permits in that case?

MR. McGREGOR: The CE handles those permit responsibilities. The CE does not issue itself permits, but we have to apply the same guidelines in maintenance dredging and disposal that we require of private and other permit applicants.

QUESTION: In Memphis, our port is usually the local sponsor, and we have to apply for the permits ourselves. To me, that's a Catch 22 because the agency requesting the disposal site also has power over the permit issuance. You are saying that in Vicksburg District your maintenance dredging projects don't require the local sponsor to obtain the permits?

MR. McGREGOR: I'm not sure how to respond in your specific case. If the CE is responsible for maintaining the channel, then I would think the CE would be responsible for the disposal area permits instead of the local sponsor.

COMMENT (MR. JOHN SMITH): Your comment that dike fields are providing interior least tern habitat is well taken, but one of the problems we have seen is the long-term probability that sandbars formed in dike fields will accrete to the shoreline. In the case of the least tern, shoreline stabilization is not a plus since the species requires midchannel bars and islands to prevent predation during nesting.

MR. McGREGOR: In a few years, the dike fields will be so stable that they won't be interior least tern habitats.

MR. SMITH: Exactly. The dynamics are being taken out of the river which will ultimately mean habitat losses to the tern.

QUESTION: In the Lake Providence project you mentioned, what was the pumping distance and size dredge you used? Did you need boosters?

MR. McGREGOR: The pumping distance was about 3,500 ft, with a contract dredge. I'm not sure of the dredge size, but I could find out from our operations people if you need to know exact size and type of dredge.

## SESSION IV: RECREATION, COMMERCIAL, AND INDUSTRIAL BENEFICIAL USE APPLICATIONS

### CLOSING REMARKS

H. Roger Hamilton
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

George and I want to thank the speakers for some very fine papers. Since we are running a little late, I will be brief in my wrap-up, but I have to tell you about the Texas shrimp herders and how they got on their horses and drove the shrimp into their little corrals---George failed to tell you that they used sea horses.

I have three points that I feel are very important and that should be considered seriously in our breakout session. All three points were brought out by our speakers. First, there is a definite need for interdisciplinary planning and management that must go into these very complex beneficial use projects. It is critical that we get the right players involved---pick the correct disciplines, orchestrate them, and make the end product come out correctly.

My second point is with regard to the geographical differences we find as we go across the US. For example, Mike Passmore pointed out the low rainfall, shallow soils, and vegetative differences in the Walla Walla District he has to work with. Few of us here have had to face those kinds of difficulties in accomplishing beneficial uses. We have to keep an open mind about the vast potential for beneficial uses in all parts of the US where dredging occurs.

My third point was noted by Marvin Jacobs from Memphis, and that is the rapid urbanization of our Nation. Accompanying that rapid urbanization are dynamic shifts in populations and the recent phenomenon of the migration from the frostbelt in the north to the sunbelt in the south. Stir in varying cultural values, different quality of life expectations, and different demands on resources. All of these translate into a need for unique products for our customers and widely varying services for our citizens.

These issues are food for thought. I hope we will discuss them in more depth at our breakout session and come up with some strong recommendations for our topic area.

## SESSION V: THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES FOR BENEFICIAL USES

### OPENING REMARKS

M. William Newstrand
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Let me add my welcome to you all to the Land of the Busy Dredge and to this technical session whose distinguished members will discuss the Great Lakes and their unique opportunities for beneficial use applications of dredged material. You are all aware of the many beneficial use programs which are currently underway on the Upper Mississippi River and in the tidewater areas and how each of them presented special problems and the need for new techniques to make them successful. What you will hear about now are programs from an area that has equally unique dredging needs with very specific problems, all of which have been or are being solved by innovative programs. Innovation is the key.

Up here in the Land of the Busy Dredge---for those of you who are not familiar with the term, this is a liberal translation of the Chippawa word "Minnesota"---each new type of beneficial use has great value. We need them because of the difficulties in costs of handling dredged material in our high bluff river thalweg and lake shore, as well as the scarcity and costs of disposal sites. There are a number of ongoing and planned beneficial use programs on our river system, many of which you have already seen or heard about in earlier papers and on the conference tour---the Weaver Bottoms project, expansion of the St. Paul downtown airport (which takes a lot of traffic out of the Twin Cities International Airport), construction and roadfill, and ice control on our streets and highways.

Our Federal and State agencies and the shipping industry pursue new and better beneficial uses on Lake Superior with equal vigor and success. For example, our Seaway Port Authority terminal sits on over 50 acres of flat surface built from dredged material; the DM&I Railroad is expanding its terminal with dredged sand; and on the Wisconsin side, the Department of Natural Resources and the CE cooperated on a demonstration beach nourishment program. In our Duluth-Superior Harbor, the existing confined disposal site for maintenance dredging is filling rapidly. It too is slated to become a terminal/ industrial site.

In addition to the ongoing maintenance dredging placement needs in the Duluth Harbor, there is an equally demanding need to accommodate the thousands of cubic yards of dredged material that will be dredged in the soon-to-be-implemented harbor-improvement program. This project will expand the existing turning basin and extend the 27-ft channel the length of the 3-mile upper harbor, which is now at only 23 ft wide.

Fortunately, the harbor improvement plan includes the construction of a 140-acre park and recreation area which will use the sand from the required dredging. Uses, such as these I have listed, help take care of most of the dredged material that we have to place.

Up here, whether it is on the river or one of the lakes, we are constantly looking for new and better ways to beneficially use dredged material. That extends all through the Great Lakes on both sides of the border. Our panel will cover the full spectrum of uses, exotic programs, and major challenges and successes. They will present papers from State, local government, private industry, and Federal (both US and Canadian) perspectives, using case studies and examples of beneficial uses.

## SESSION V: THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES FOR BENEFICIAL USES

# AN OVERVIEW OF PAST AND POTENTIAL NATURAL RESOURCE BENEFICIAL USES OF DREDGED MATERIAL IN THE GREAT LAKES

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### Introduction

You have already heard much about the Great Lakes, its environmental problems, and the concerns expressed by yesterday's panelists, so in my talk I wanted to discuss some of the opportunities associated with dredging and dredged material disposal in the Great Lakes. These opportunities exist in both the US and Canadian waters.

Dave Cowgill, our session's co-chairman, asked if I would give a brief overview on past and potential beneficial uses in the Great Lakes that would lead into the following papers. As I thought about the topic and read back over the various studies and work I had been involved with in the Great Lakes since 1974, I realized that there are actually several distinct types and magnitudes of natural resource and recreation-oriented beneficial uses in the Great Lakes.

Before I get into those, I would like to preface this with information on early beneficial uses in the Great Lakes. For over 100 years, most of the early dredging work in all of the Great Lakes was used to create fast land, to fill in wetlands, and to stabilize shorelines. These commercial and industrial uses still occur, but at a much lower level, and usually are in the form of port expansion or industrial expansion onto land created by confined disposal areas.

### Island Beneficial Uses

Also in early dredging work, there were cases in connecting rivers and in other shallow parts of the Great Lakes where dredged material was sidecast into shallow water long enough to form islands. These islands later became recreational sites (i.e., Belle Isle Park in Detroit and others) or wildlife habitats primarily used by nesting sea and wading birds, depending upon the vegetation that colonized them, the size and configuration of the island, and the level of disturbance they received.

During the Dredged Material Research Program, we conducted joint studies with the FWS in the US Great Lakes and found that there were 50 dredged material sites and islands at that time (1976-1978) with active waterbird nesting colonies (Figure 1). The waterbirds of the Great Lakes use a higher

percentage of natural islands and sites than dredged material sites for nesting because there are still some prime nesting habitats available to them in a number of areas around the Great Lakes. However, we found that virtually every dredged material island or isolated dredged material site in the US Great Lakes that was surveyed had a nesting colony on it.

This indicated to us that there was a scarcity of available natural habitats for species nesting in parts of the Great Lakes where most of the dredged material islands occur (bays and harbors, connecting rivers, and shallow water areas). More recent surveys indicate that these same areas are still receiving equal and sometimes even greater use by nesting waterbirds where the manmade habitats are still available to them.

## Species Nesting on Dredged Material

The greatest nesting use of dredged material islands and sites is by four species: common terns, Caspian terns, ring-billed gulls, and herring gulls. Over 65,000 were nesting in 1977, for example, on dredged material in the Great Lakes. These birds tend to prefer habitats ranging from bare ground to medium-dense herbaceous vegetation for nesting sites, plant communities which are common on newly constructed or continuously disturbed dredged material sites. Dredging cycles and the dikes in confined areas are well-suited to these species because placement of new deposits of dredged material sets back the successional stage of vegetation development and allows the birds to nest.

There are also small numbers of black-crowned night-herons, double-crested cormorants, great blue herons, great egrets, and cattle egrets nesting on dredged material in the Great Lakes, and this use is increasing, especially in CDFs. These wading bird species generally require woody vegetation of sufficient age and structure to support large nests off the ground, uncommon habitats on dredged material in the US Great Lakes. However, wading birds are still frequent users of dredged material sites because they will nest in areas containing woody vegetation that are influenced by dredged material deposits (i.e., Pointe Mouillee in Lake Erie), and they will fly great distances from their nesting colonies on natural islands to feed in the protected shallow water areas inside dredged material placement sites.

The endangered piping plover has been found in past surveys to be using dredged material islands with bare ground habitat, and this use is being encouraged by both State agencies and the CE Districts who have responsibility for the Great Lakes.

## Other Wildlife Uses

During migration, especially in the fall, tremendous flocks of shorebirds can be found feeding in and around dredged material mud flats. This is more a phenomenon of CDFs than older unconfined islands and sites. However, these migrating species will use all available habitats. Waterfowl also frequent dredged material sites with shallow ponded areas as they migrate from their summer grounds to Central and South America and coastal North America.

Mammal use on older types of dredged material sites and islands, and those newer ones that are not CDFs, is very limited due to their small size,

location in the Great Lakes, and other factors. In fact, this very limit in mammalian access helps the nesting waterbirds because it is a controlling factor on predation on their nests, eggs, and chicks. Where islands were built close enough to shore, or disposal areas were connected to the mainland, and were large enough to support mammalian predators such as foxes and raccoons, there has never been much nesting activity.

Types of Habitats

The older island habitats generally tend to be small and are also generally colonized with herbaceous vegetation that is set back annually by the activities of the nesting birds. Where sufficient time and lack of disturbance has occurred to allow woody vegetation to grow, this has occurred on very few sites. Where dredged material placement still occurs (very rarely in the Age of CDFs), bare ground habitat also occurs on these older sites.

These older islands and sites are concentrated in such areas as the Detroit River (Mud Island and others) (Figure 2), the St. Marys River (a series of islands near Saulte Ste. Marie), the Niagara River near Buffalo, along the shallow Lake Erie shoreline, in Lake St. Clair, in the Toledo harbor, the Duluth harbor, and other bays and rivers.

The greatest management problem with these older sites is erosion. For example, a number of the islands in the St. Marys River have been completely eroded away and others have been greatly reduced in size. These islands were once heavily used by nesting common terns and other seabirds, but that use has been greatly reduced. Larger dredged material islands in the Detroit River such as Mud Island that support nesting colonies of several thousand seabirds each year have been riprapped to stabilize them and prevent erosion.

The second largest natural resource management problem on islands near urban centers (such as those around the city of Detroit) is a "people problem." Recreational activities and wildlife use can sometimes be in conflict, especially where nesting habitats are concerned. I will talk about that more in a few minutes.

## Aquatic Beneficial Uses

Although there has probably been more of this type of dredged material use than has been documented, aquatic habitat enhancement has been occurring in the Great Lakes using dredged material for many years. This has taken the form of using coarse-grained material, stones from new work projects, and other rubble from construction projects to create fishing reefs and stillwater aquatic habitat areas.

Prior to the 1970's, most of this has been unintentional on the part of the CE, although local communities have intentionally enhanced sport fishing using these methods. There also has been considerable unintentional aquatic habitat developed by the CE when riprapped dikes were used for CDFs. These large stones have provided variations such as topography relief, cover for small fish and other aquatic organisms, and food sources for larger fish.

## Confined Disposal Facilities (CDFs)

### Background

I should probably title this section "multiple beneficial uses of dredged material" since that is exactly what CDFs have provided since their inception in the Great Lakes about 20 years ago. There are more than 30 large CDFs in the US Great Lakes. They were built primarily to hold Great Lake sediments that were considered to be highly contaminated from many years of industrial and commercial dumping and flushing into the Great Lakes. These CDFs tend to be concentrated in Great Lake harbors such as Saginaw, Green Bay, Toledo, Detroit, Chicago, Buffalo, Duluth, and numerous others.

In general, the CDFs in the Great Lakes were built offshore in shallow water areas, and were designed to be as impermeable as possible. Most were also compartmentalized so that dredged material could be placed in one cell while another was dewatering (Figure 3). Larger ones with more than two cells have several development stages occurring at any given time.

Very few of the earliest Great Lakes CDFs were built with wildlife or fisheries habitat as an objective. This was due primarily to two factors. The first was that when the earliest ones were designed, almost no CE projects had habitat development designed into them; rather, projects were built to accomplish the primary objective of dredged material containment. The second is that since the dredged material was supposed to be contaminated, in the eyes of many FWS, EPA, and State personnel, wildlife and fisheries use should not be encouraged.

Well, in their instinctive wisdom that we humans did not have, wildlife species were attracted to these CDFs in large numbers. Since the CDFs were built offshore, or at least cut off from the mainland by high fences and locked access roads, their isolation and their habitat types brought in large numbers of avian species to feed and nest. I still remember heated discussions with FWS personnel in the 1970s in which they wanted the CE to find ways to drive away the feeding and nesting birds because they didn't want them on what they viewed as death traps due to the contaminated sediments! My response to such thoughts was that the nesting gulls scavenged everywhere for food, including the city garbage dumps, and not just in CDFs; that nesting terns were strictly fish eaters, and that they were fishing outside the CDFs for the small fishes they needed to feed their chicks; and that there was no practical way to keep night-herons and other wading birds from flying in to feed inside CDFs.

In the meantime, these early CDFs were developing their own wetlands with accompanying wetland and aquatic organisms, which increased wildlife use. A case in point is Times Beach, NY, in Buffalo CE District (Figure 4). The locals were initially opposed to the Times Beach CDF. However, over time and before the next dredging cycle, it developed into a lush, highly-productive freshwater wetland that was one of the best birding and natural resource recreational spots in the area. It was so good, in fact, that Buffalo District had to give it up as an active disposal site, and build a new CDF to hold their dredged material. This CDF now has frequent visitors, nature

trails, and other recreational amenities, and will not in the foreseeable future be used for new dredged material deposits. Subsequent studies have not shown the contaminated sediment to be causing great problems with biomagnification and plant and organism uptake.

With all of the wildlife and fisheries use occurring naturally, and with greater emphasis within CE offices on environmental concerns, CDFs now generally have natural resource considerations and habitat designs incorporated into them. They are also now treated as multiple resource units that provide greater benefits to the public than to just hold dredged material. Pointe Mouillee is an excellent example of this multiple use concept, as well as of long-term planning and management.

There have been a few isolated problems. One has been finding some deformed chicks in a colony on the CDF dike at Green Bay, WI, where the entire bay and all its sediments are considered contaminated to some degree from historic Fox River industrial pollution. Investigations have not revealed whether the chicks were deformed due to contaminated fish, and especially, from contaminated fish from within the CDF.

Another problem has been the occurrence of avian botulism in two CDFs, but this problem has been relatively easy to manage. This is done in a CDF by standard water management practices---either the botulism area is flooded and flushed to prevent stagnant water buildup, or drained and filled inside the CDF between dredging cycles to remove ponding.

## General CDF Wildlife and Fisheries Use

Because CDFs are very large ongoing dredged material placement sites, and because they are carefully planned and designed to incorporate such features as compartments, permanent weirs, and relative isolation, they have become prime wildlife habitats. For example, Saginaw CDF has contained a nesting colony of terns and gulls for many years, and now has a colony of herons and egrets nesting in young trees. In 1987, there were 11 CDFs throughout the Great Lakes with nesting colonies. Those CDFs which incorporate bodies of water inside or behind them have become prime fish habitats as well.

Since a number of these CDFs have land access that is controlled by locked gates and fences, it is difficult but not impossible for people and small mammals to reach them. Therefore, some of the larger CDFs have resident raccoon, cottontail, woodchuck, muskrat and other rodent and reptilian populations, and occasional visitors such as white-tailed deer and foxes have been observed or reported.

## General CDF Recreational Use

I have already noted the use of Times Beach CDF by bird watchers, hikers, and others. I will give many details on Pointe Mouillee in the next section, but I wanted to emphasize here that people, as well as wildlife, have discovered the CDFs. As I have pointed out, most are off limits by virtue of being islands or being behind locked gates, but that has not prevented boaters, joggers, bird watchers, and other pedestrian recreationalists from using these sites. Sport fishermen have also discovered the prime fishing

habitats provided by riprapped dikes and stillwater areas in and around CDFs. They come by boat or by foot to fish around some of the CDFs like Pointe Mouillee. Some CDFs have also provided stillwater harbors for small boats, and commercial marinas are taking advantage of this protection.

## Shoreline Stabilization

In a period of fluctuating Great Lake levels, during which in the 1970's lake levels were fairly low but by the mid-1980's were at record high levels and now suddenly in 1987 are starting to drop again due to midwest drought conditions, shoreline stabilization provided by CDFs has been invaluable. It has also been seen by shoreline residents and managers as something they would like to see more of. For example, the Pointe Mouillee CDF has provided protection for over 4,000 acres of eroded wetlands that are now being restored in western Lake Erie, and on either side of that CDF, people had their homes sandbagged to keep out rising lake water.

Just down the lakeshore and south to Toledo, however, shorelines are experiencing terrible erosion problems. The CDF built at Sterling State Park was built in part to stabilize the shoreline there, as well as to hold material from Monroe, MI, and part of the material was used for beach nourishment. The Monroe CDF is also providing considerable migratory habitat for cormorants and other diving birds until it is filled beyond the open water stage of development. Resource managers would like the CE to build such a structure downshore from Monroe CDF at Woodtick Peninsula in western Lake Erie, which is experiencing extreme erosion.

A number of the Great Lakes CDFs are helping with shoreline stabilization and with creating stable islands in the Great Lakes, as compared to the older type of dredged material islands which are impacted by wave and wind action and water levels.

# A Case Study: Pointe Mouillee CDF

## Background

Pointe Mouillee State Game Area was once one of the finest freshwater marshes and recreational fishing and waterfowl hunting areas in the Great Lakes, and is becoming so again. Record lake levels and severe erosion in the 1950's greatly reduced the 4,600-acre site to a highly wave-impacted, open-water area and completely removed a barrier island that had originally protected the site.

Through a mutual need and cooperative effort, the Detroit CE District and the Michigan Department of Natural Resources (MDNR) agreed to build a 900-acre CDF in the configuration and location of the old barrier island, with cross-dikes at each end leading to the shoreline (Figure 5). The CE financed construction costs while the MDNR agreed to provide all natural resource management.

The Pointe Mouillee project has a number of objectives. However, the primary ones were to: (1) protect and stabilize the wetlands and shoreline inside the state game area; (2) reestablish the marsh through encouragement of sedimentation and plant colonization; (3) establish a multiuse recreational site on both the confined disposal facility and the game area (visitors center, waterfowl and small game hunting, fishing, boating, bird watching, hiking, jogging, etc.); and (4) provide a place to dispose of maintenance material from western Lake Erie harbors and channels.

To accomplish these objectives as efficiently and as cost-effectively as possible, a draft long-term management plan for the site was drawn up while construction was under way. Features such as gated culverts to allow for water to flow through the marsh, access crossdikes, dredged material island formation within the marsh for nesting waterfowl, and intensive wildlife management were incorporated. The potential impacts of the construction activities and dredged material placement were examined.

## Monitoring and Management

Monitoring of this site has not been extensive; however, wildlife and vegetation data have been collected since 1979; water quality and contaminant monitoring has been conducted; and recreational use surveys with fishermen and other site uses have been made. Construction of the CDF and the crossdikes was completed in 1983.

The MDNR carries out a year-round schedule of recreational and management activities at Pointe Mouillee. For example, game management employees plant extensive food crops for migratory waterfowl and resident wildlife at Pointe Mouillee. They have established trails, fishing piers, picnic facilities, a visitors center, a marina, and hiking and jogging areas on the dredged material site. Vehicular access is limited for safety and provides higher quality visitor experiences. The MDNR intends at some point to fluctuate water levels for vegetation manipulation within the marsh and to provide more fishing and day-use facilities such as additional picnicking and hiking areas.

## Current and Anticipated Benefits of the Site

Monitoring and interviews at the 4,600-acre site has shown that: (1) soon after it is placed, the dredged material is colonizing with herbaceous vegetation with both wetland and upland plant species, primarily cattail and common reed (Figure 6); (2) the site is receiving ever-increasing wildlife and fish use by resident, migratory, and nesting species; (3) the site is finding wide acceptance by local and regional citizens for recreational purposes; (4) the CDF is carrying out its purpose of holding maintenance-dredged material as intended as an ongoing activity and has many years' life left for additional material placement; (5) emergent marsh vegetation is slowly increasing inside the eroded wetland portion of the game area but not as quickly as anticipated due to recent record-high lake levels; and (6) contaminants were not found to be a problem due to leaching below the root zone of upland vegetation in the facility and to the relative stability of contaminants in wetland soil conditions.

Year-round fishing, including ice fishing, is very popular at Pointe Mouillee, and bird-watching clubs from three states and Ontario regularly congregate at the mud flats, marshes, and dike areas of the CDF due to the very high species diversity, especially during migration. Waterfowl events such as duck-calling and decoy-carving contests are held annually, and fishing events are held in the summers.

Actual monitoring has resulted in the observation over time of some 145 bird species using Pointe Mouillee, and year-round mammal residents include beavers, muskrats, woodchucks, occasional white-tailed deer, eastern cottontails, and others. Black-crowned night-herons and herring and ring-billed gulls now nest in colonies at Pointe Mouillee.

Beneficial uses of the CDF and game area at Pointe Mouillee are many and varied, and the quality of habitat and recreational experience is expected to increase. Pointe Mouillee received the CE Environmental Honor Award for 1983.

## Summary

CE dredged material sites throughout the Great Lakes are without question providing wildlife and fish habitats. Dredged material islands and sites surveyed during the late 1970's found 100 percent of these sites in use by wildlife. The advent of CDFs has only increased the use of a number of CE dredged material sites. All CDFs are receiving some level of wildlife and fish use, and over 30 percent of the new CDFs are being used as nesting-colony sites by waterbirds. CDFs are also providing mammalian and reptilian habitats due to their size and diversity.

In addition to the habitats dredged material sites in the Great Lakes have provided, there is also a tremendous amount of natural resource-related recreation associated with them---fishing, hunting, boating, bird watching, hiking, biking, and nature trails. In short, the CDFs and other dredged material sites in the Great Lakes are serving as multiple use resources that benefit the people of the Great Lakes States and Provinces in many ways.

QUESTION: Is the use at Pointe Mouillee CDF restricted to heavily contaminated dredged material? Is there an effort to complete the CDF more quickly so that other benefits can be enjoyed faster?

DR. LANDIN: Yes, the site was used for contaminated dredged material, and it still is to some extent, but the worst material is now on the bottom of the CDF. At the time of the long-term management plan development, there was an intention of capping the dredged material with a layer of clean material to prevent translocation of contaminants into plant material. However, the coarse-grained material has leached, and now this capping does not appear to be necessary except possibly for landscaping purposes and to place topsoil to allow better upland plant growth.

QUESTION: Is there any active monitoring program for contaminants in migratory birds in CDFs, either in preflight birds or in adults?

DR. LANDIN: Most monitoring that is taking place is at the District or State level on a site-by-site and as-needed basis. In some cases, there is no wildlife monitoring at all because no problems have arisen such as the two isolated avian botulism outbreaks we talked about yesterday.

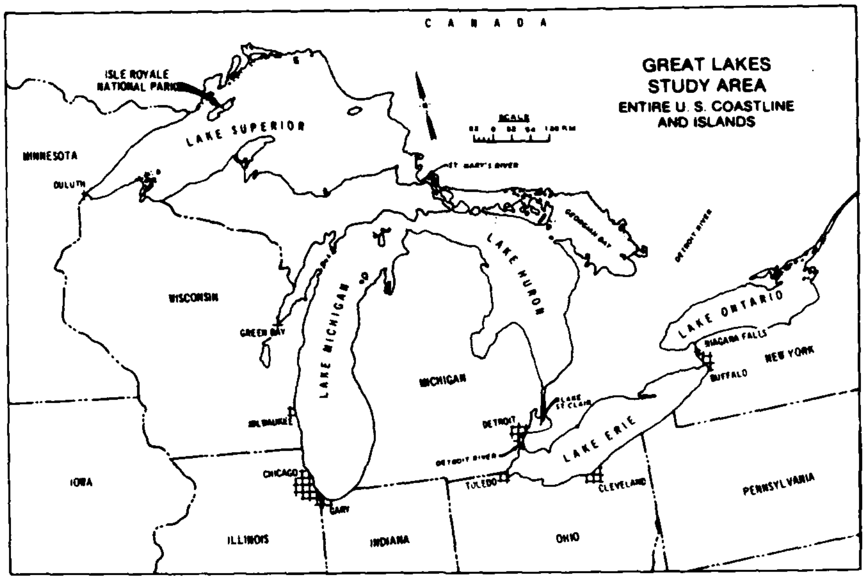


Figure 1. A schematic view of the US Great Lakes study area during the Dredged Material Research Program, in which virtually 100 percent of the dredged material islands and sites were found to be receiving wildlife use

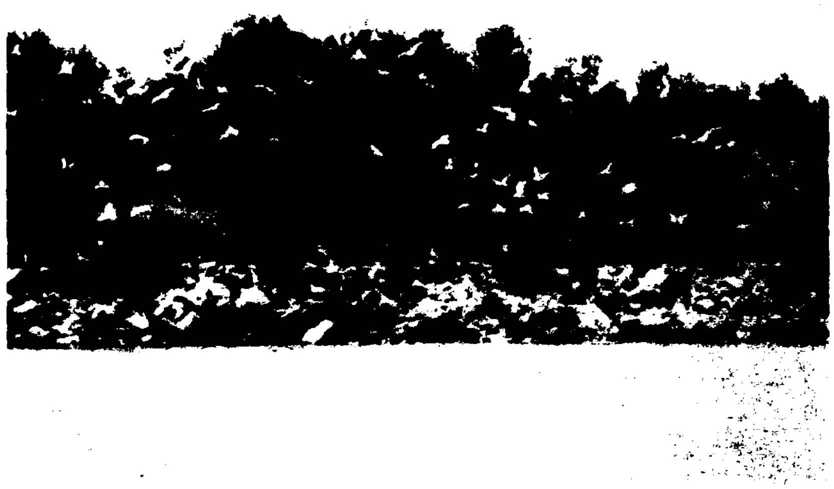

Figure 2. Mud Island, a dredged material island in the Detroit River, has been used by thousands of ring-billed gulls for nesting for many years

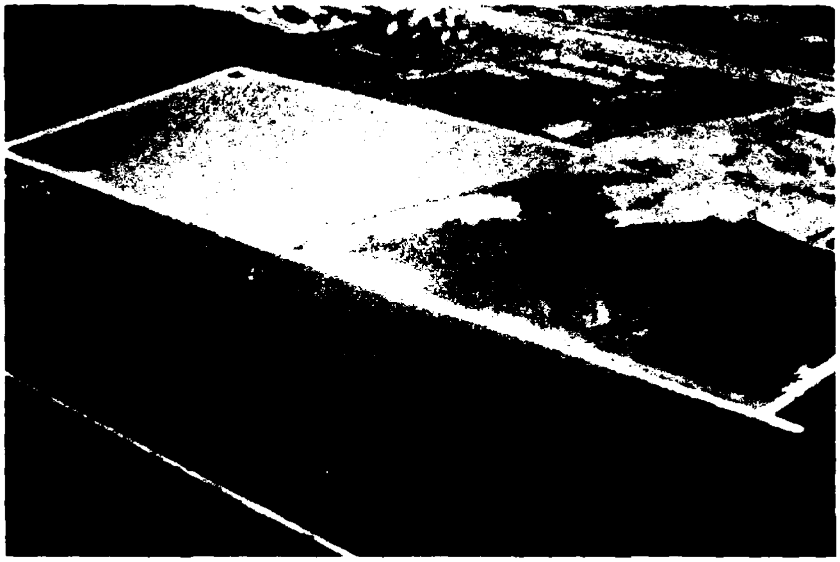

Figure 3. An aerial view of the Dike No. 12 CDF at Cleveland, OH, showing the compartment concept that allows dewatering in one cell while the other cell is in use

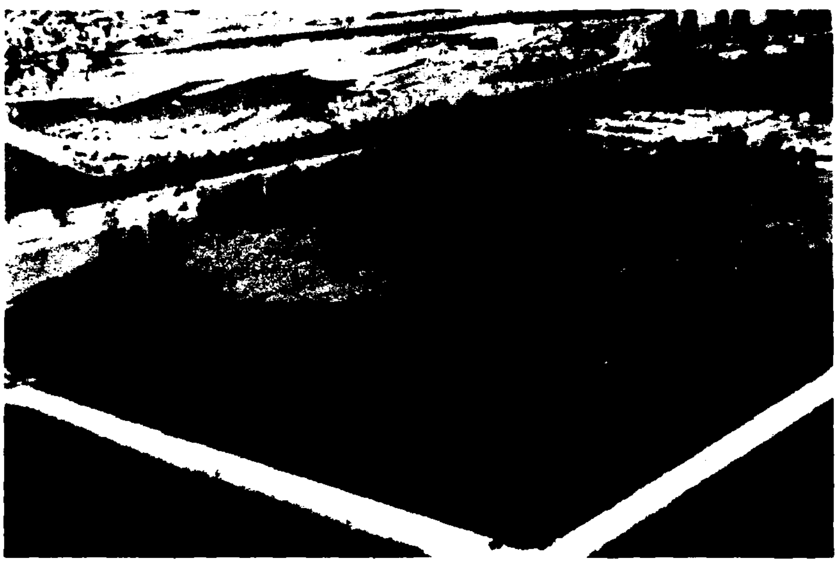

Figure 4. Times Beach CDF in New York is now a lush freshwater wetland that receives considerable natural resource and recreational use

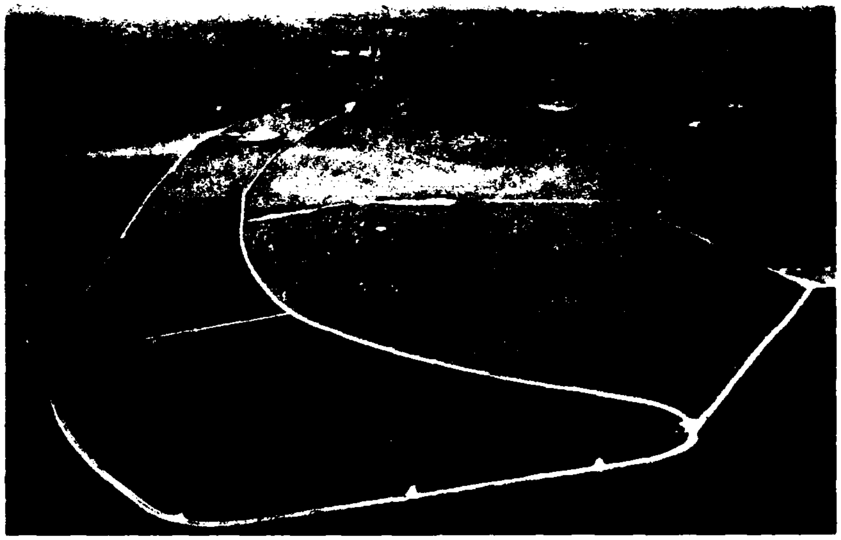

Figure 5. An aerial view of the Pointe Mouillee CDF, showing its compartments, its location in relation to the mainland and crossdikes, and the game area wetland that the CDF protects from erosion

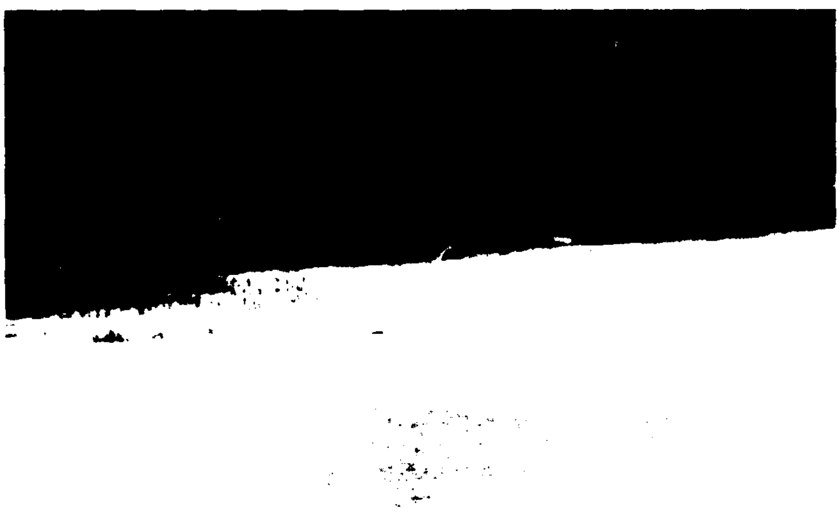

Figure 6. The middle compartment in the Pointe Mouillee CDF currently contains a shallow freshwater wetland and receives heavy use by muskrats and other water-related wildlife, including feeding wading birds

## SESSION V: THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES FOR BENEFICIAL USES

# A VIEW FROM WISCONSIN ON THE BENEFICIAL USES OF DREDGED MATERIAL

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Madison, Wisconsin

Along the Lake Michigan and Lake Superior coastlines and up and down the Mississippi River, hundreds of thousands of cubic yards of sediment are dredged each year to keep Wisconsin's waters open for navigation. Procedures for the disposal of the dredged material are becoming increasingly complex. Choosing between the many available disposal options requires an understanding of the economic, legal, and environmental issues surrounding dredging and dredged material disposal.

I want to talk to you today as a regulator because that is what my agency and I are. We do not sponsor or do dredging projects. However, dredging and disposal of dredged material is a primary concern of the Wisconsin Department of Natural Resources. When dredged material is unpolluted by EPA and DNR standards, many options exist under existing state laws for the disposal of the material, including many beneficial uses:

a. Permanent upland disposal - Filling an abandoned gravel pit or creating a diked disposal area are examples of permanent upland disposal.

b. Transfer/reuse site - A permanent site for storage of reusable materials. A number of sites have been created along the Mississippi River that are used for road sanding and fill material. Similar sites are also located in some of our Great Lakes harbors.

c. Shore protection - Using dredged material in riprap or other shore protection projects has been quite successful.

d. Fill behind bulkheads - Dredged material has been used as fill behind bulkheads.

e. Marsh restoration/creation - Instead of creating dry land, fill may be used to create or restore wetland conditions. Field trip participants saw a number of examples along the Mississippi, and we have been quite good at creating wetlands in our Great Lakes confined disposal facilities.

f. Beach nourishment - Clean dredged material can be used to nourish an existing beach as a shore protection method. This has been attempted several times on our Great Lakes with very mixed results---mostly because of the extremely high wave energies that we experience.

Other options for the disposal of dredged materials that have been done in Wisconsin include:

*a*. Construction of breakwaters, jetties, groins, etc.

*b*. Construction of marinas and harbor facilities.

*c*. Construction of bridges and/or causeways.

*d*. Construction of parks, roads, sewage treatment facilities, etc.

*e*. Surface application on agricultural land as a soil conditioner.

*f*. Capping for landfills and confined disposal facilities.

*g*. Highway ice control.

*h*. Bedding material for sewer and water pipelines.

The list of disposal options indicates that there are many reasonable methods of disposing of dredged material in Wisconsin. However, inwater disposal of dredged material not as part of a structure is generally prohibited by state law (the Mississippi River is one exception to this prohibition).

Obviously, concerns have been raised about this restriction. The primary concerns have been:

*a*. Significant added costs.

*b*. Impracticality of on-land disposal because of land availability and equipment limitations.

*c*. Adverse environmental impacts at on-land disposal sites.

Because of these concerns, the Wisconsin Department of Natural Resources (WDNR) has taken a number of actions.

First, in the early 1980's, we were involved in two demonstration projects of beach nourishment. One of them was on-beach placement in Lake Michigan; the other was nearshore placement in Lake Superior to nourish and stabilize a landfill site. These two projects were very carefully studied in-house and by the University of Wisconsin's Center for Great Lakes Studies.

Second, a technical committee was formed to determine sediment quality suitability for in-water disposal. The committee looked at the 1977 EPA guidelines for contaminant levels, current research and literature, and then modified those criteria and developed a tiered testing system. The first tier is a review of existing data and possible pollution sources. The second tier is bulk sediment sampling and analysis. The third tier is bioassay or other tests. The department is now in the last year of a 3-year study with the CE to determine the bioassay techniques to be used in Wisconsin.

Third, an in-place pollutant committee was formed to look at the kinds and levels of contaminants we have to deal with in Wisconsin, our regulatory mechanisms and administrative procedures, and how difficult it is for the regulated parties to get through the regulatory process.

As a result, the department is revising its regulations on dredging and dredged material disposal and is drafting legislation that would allow in-water disposal of clean material in the Great Lakes. The legislation requires a beneficial use of dredged material placed in-water. The Wisconsin Constitution and various State Supreme Court interpretations of it---a body of law collectively known as the Public Trust Doctrine - obligates us to require a beneficial use.

While we feel that a benefit is necessary, we as regulators are struggling with a great number of questions. The biggest is how do you define beneficial use?

Do we require a substantial benefit, or do we accept any benefit whatsoever as long as no harm results? For example, in the case of beach nourishment disposal, do we require an 80 percent sand particle size standard like the State of Illinois, or do we just require that some sand size fraction be present - on the theory that some sand will nourish the beach and no harm will occur?

Do we consider open water disposal or subaqueous borrow pit filling a beneficial use - where the only benefit is least cost disposal? We certainly have heard this numerous times from dredging sponsors in Wisconsin.

Do we require that the benefit be direct and demonstrable or quantifiable? Do we have the science or technology that can measure these things?

Is a confined disposal facility a beneficial use by itself?

Is using the least cost alternative for disposal a beneficial use? Does economics outweigh other concerns?

I am sure that the regulators and the doers in the audience have other or similar questions. But, like it or not, we regulators will have to define beneficial use.

I have no answers today. But, I will have to find those answers in the next few months. Perhaps, as Mary Landin has suggested, beneficial use is in the eye of the beholder, and any definition should be subjective and determined case by case by the regulator.

Before I respond to any questions, I would like to respond to the last question that was asked of Mary Landin about monitoring of CDFs. She replied that it was generally done by the state or CE district, if at all. That is true, and in Wisconsin, we have looked at mortality and body burdens in birds at the Green Bay CDF with the US Fish and Wildlife Service. However, monitoring as a whole has been very limited. As far as the deformities being caused by contaminants, it depends upon whose theory you want to believe as to whether it is from the overall contaminated Green Bay food chain or directly from the CDF. We really don't know.

QUESTION: We have a project in Seattle CE District where we were told the dredged material was considered unsuitable for open water disposal. However,

the state said it was suitable for farmland and agricultural enhancement where we grow crops to eat. Would you care to comment on that?

MR. HAUSMANN: We have talked a lot about clean material. The question you are raising is what are we going to do with mildly contaminated material? For your example, I think in Wisconsin we would have said that it was a benefit and as long as it met ground water standards, land spreading would be okay. However, dewatering and hauling the material is an added cost, and no one is going to want to pay for it. Then you're back to square one. I wish I had an answer for you, but I really don't other than these situations are going to be a challenge for all of us.

## SESSION V: THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES FOR BENEFICIAL USES

### A VIEW FROM MICHIGAN ON THE BENEFICIAL USES OF DREDGED MATERIAL

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Michigan is blessed with 3,200 miles of shoreline on four of the Great Lakes. The Great Lakes and shorelines are a precious social and economic resource to the people of Michigan with our second industry, tourism, focused on the Great Lakes.

Navigation is an important component in the use of this resource. We have 91 public harbors including 48 Federal recreation harbors, 25 Federal commercial harbors, and 164 miles of connecting channels. An average of 8 billion dollars in commerce moves through Michigan's commercial ports annually. The 48 recreational harbors help support a fleet of 750,000 registered pleasure boats and a recreational boating industry that contributes $410,000,000 annually to the state's economy. In addition, the Great Lakes sport fishery, which is dependent upon good harbors, provides another $450,000,000 in income to the state.

The Michigan Department of Natural Resources (MDNR) strives to balance protection and use of the Great Lakes resource. Our philosophy on dredging is to accommodate the needs of navigation while protecting the environment and seeking beneficial uses of dredged material. In many respects, dredged material is viewed as a misplaced resource. The MDNR has a long history of promoting beneficial uses. With the support of the CE and the cooperation of the EPA, the FWS, and local communities, we have numerous examples of beneficial use applications.

In Michigan, the most common beneficial use of dredged material is beach nourishment. In 1987, 18 of our 19 Federal projects involving nonpolluted material employed beach nourishment disposal. The CE and their contractors have cooperated to place material on or near the shoreline. Mechanical or bucket dredges use beach scows that are moved landward of the 8-ft contour and unloaded. Hydraulic dredge and pipeline operations, the most common dredging and disposal technique, place material directly onto the shoreline or in the nearshore zone.

Dredged material problems in Michigan are dominated by those harbors which have contaminated sediments unsuitable for disposal in the aquatic environment. These include portions of most of our commercial harbors, a few recreational harbors, and portions of the connecting channels. Even at these harbors and channels where direct use of the dredged material may not be possible, we attempt to use confinement facilities (CDF) and construction features in beneficial ways.

We are very proud of the beneficial aspects of two of our most recent and largest CDF projects. Both projects are on Lake Erie in southeast Michigan.

The Pointe Mouillee CDF is our largest facility. It occupies 685 acres of Lake Erie bottomland, stretches approximately 3.5 miles long by 0.25 mile wide, and will contain 18.5 MCY of dredged material from the Detroit and Rogue Rivers when full. The CDF is constructed within the Pointe Mouillee State Game Area on the site of a former barrier beach. The CDF presents opportunities for public use and recreation both on and landward of the CDF, none of which would have been possible without the barrier island protection afforded by the CDF. The CDF provides protection for deepwater access from a private marina, and that is allowing restoration of 3,500 acres of former wetland and 600 acres of potential wetland. CDF construction features and a CE wetland establishment project will restore 1,400 acres of prime wetland habitat and provide for multiple recreational opportunities, all in close proximity to the largest concentration of people in the state.

Another CDF has recently been constructed for nearby Monroe Harbor at Sterling State Park. Sterling State Park, a MDNR-managed multiple-use park, is one of the most intensely used parks in Michigan with approximately 1,000,000 visitors annually. The CDF project occupies approximately 90 acres of upland and bottomland on the Lake Erie shoreline. It will hold 4.2 MCY of sediment from the River Raisin. Sterling State Park has a history of water-quality problems, lake flooding, and poor access. CDF location, construction features, and use of the excavated material will help solve park erosion problems. Excavated material has been used to raise day-use and campground facilities to higher elevations and to improve wildlife habitat areas. The CDF itself provides a 50-acre increase in park day-use area, deepwater fishing access, and a scenic view of Lake Erie.

Much has been accomplished through cooperation and compromise to accommodate maintenance dredging needs and provide secondary benefits. However, there are challenges which must be addressed for continuing progress in changing economic and political environments. The MDNR has four major concerns in this area.

First, lower-cost disposal techniques are needed if State and local governments are to assume a greater role in dredged material handling. Research is needed to determine the practicability and environmental acceptability of such disposal techniques as upland confined disposal, open water disposal techniques for contaminated material, and reuse of material in CDF's.

Second, studies on contaminant uptake and biological validation of the criteria used to determine contamination are needed to find the most cost-effective and beneficial solutions to our dredging problems.

Third, agencies and communities must communicate and be able to cooperate and compromise to come to timely acceptable solutions.

Fourth, cost-sharing and Federal transfer of responsibility for the contaminated material will be a problem for State and local offices. Multi-state and Federal interests may not be well-served in situations similar to Michigan's where we will be asked to provide the non-Federal cost-share of 164 miles of connecting channels and a major lock facility when only a small percentage of the commerce passing through these transportation routes has an origin or destination in Michigan.

## SESSION V: THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES FOR BENEFICIAL USES

# AN OVERVIEW OF ALTERNATIVES FOR TOLEDO HARBOR, FOCUSING ON COMMERCIAL, AGRICULTURAL, AND UPLAND REUSE

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Toledo Metropolitan Council of Governments
Toledo, Ohio

John Hull
Hull and Associates Inc.
Toledo, Ohio

## Background

Toledo Harbor is the third largest port on the Great Lakes with some 20 million tons of commerce and industry goods shipped annually. Toledo Harbor holds another distinction. It accounts for 18 percent of all the dredging in the Great Lakes. At a million cubic yards to be dredged annually, Toledo is about twice as large as the second-ranked dredging project. This volume of dredging is the result of the location of Toledo Harbor along the Maumee River at the entrance of Maumee Bay. The port facilities and channel extend along 7 miles through the shallow bay water to reach deeper Lake Erie water. Sediment from the rich agricultural lands of the Maumee River watershed clogs the channel and deposits large sediment loads into the bay.

Historically, the shipping channel has been dredged and the material placed in the cheapest location along the banks of the river and in Lake Erie or Maumee Bay. Several traditional dike disposal facilities are located along the river. In the 1960's, Island 18 was constructed as an economical location to place the material. In 1975, after considerable opposition, a new CDF (Facility No. 3) was constructed in response to the requirements of the Clean Water Act and the necessity to confine polluted dredged material. Testing of the sediments in 1983 indicated that some improvement has occurred in the quality of the sediment in the Maumee Bay portion of the shipping channel. Although the EPA considered the sediment from the area of Lake Mile 2 to the outermost area of the dredging project "suitable for open lake disposal," this decision has not been accepted by the State and local governments. It is considered to be contrary to the water quality improvement efforts that are at the heart of the revitalization of the Western Basin of Lake Erie.

Therefore, Ohio EPA has set in motion a 5-year timetable to eliminate open lake disposal. This issue is not the subject today, but it is important because it has been the catalyst for the effort to seek alternative dredged material management methods. There are apparently only three basic alternatives for dredged material disposal in the Toledo Harbor: (a) open water disposal, (b) additional CDF's, and (c) beneficial reuse of the dredged material. There is considerable opposition to alternatives (a) and (b); however,

everyone agrees that (c) is the most sensible choice we have for Toledo Harbor.

## Exploring Beneficial Use Alternatives

Since 1985, there have been several meetings of the numerous government agencies that have an interest in reuse alternatives. The Toledo Metropolitan Area Council of Governments has organized these sessions and arranged for the examination of alternatives with small grants from the CE and the EPA through the Ohio EPA. The following steps are underway.

### Quantify Volumes and Characterize Sediment

The CE has assisted in developing information about the dredged material in terms of annual quantities and evaluation of toxic substances. The material has generally been classified as suitable for reuse alternatives including topsoil for use around homes. Particle sizes vary, but the majority of the material is composed of nonorganic silt- and clay-sized particles.

### Identify Potential Alternatives

A list of potential alternatives was developed by group brainstorming and contact with many potential public and private users.

### Preliminary Analysis of Potential Alternatives

A grant from the Ohio Department of Transportation was matched with additional local funds from the Council of Governments and the Toledo/Lucas County Port Authority to provide a systematic review of these alternatives. This grant was used to retain John Hull, a consultant to help us analyze the alternatives, and my co-author on this paper. This analysis is currently being completed, and the final results have not yet been reported back to all of the participating agencies. However, John is going to present to you now his preliminary findings.

## Characterization and Approach

Past approaches to disposal of the 1 MCY disposed of annually in Toledo Harbor have been handled as short-term management problems. However, the nature of the problem actually requires long-term management alternatives to be more competitive from a cost/benefit standpoint and to be more attractive with regard to environmental impacts/beneficial uses of dredged material. To that end, we began a preliminary study of the feasibility of alternate methods of dredged material management. Ed has already given you the first three steps we followed in our feasibility study. Step 4 is to review the identified alternatives and select the best one. Step 5 calls for detailed investigation of cost, logistics, capacity, final use, impacts, and any other necessary followup of the selected alternative. This would include monitoring maintenance, and any active management of the beneficial use

activity that would be the responsibility of the Port Authority or Council of Governments.

## Findings

We identified four broad alternatives with potential for Toledo Harbor's disposal problems. These include (a) shoreline erosion control, such as at Woodtick Peninsula; (b) local construction/fill projects; (c) use as topsoil or for strip mine reclamation; and (d) confinement. The confinement alternative has five sub-alternatives: (1) expansion of existing CDFs; (2) reuse of existing CDFs as they are; (3) upland temporarily confined disposal; (4) land reclamation; and (5) construction of a recreational hill for skiing and other sliding sports. When approached from a long-term standpoint, all of the above appear feasible except for continuing construction of CDFs in nearshore locations that would cause the loss of existing fish habitat. Since CDFs in the Toledo and other Great Lakes locations seem to attract wildlife, especially nesting seabirds, CDFs sometimes actually replace fish habitat (shallow lake bottom) with wildlife habitat (protected island CDFs).

None of the identified alternatives could provide a long-term disposal capacity by itself except for upland recreational hill and strip mine reclamation where large quantities of material could be utilized. It is likely that a combination of alternatives will be necessary. Several of the alternatives can be easily implemented concurrently to provide more than adequate volume for long-term needs.

Another important finding is that there are uses to which the dredged material could be put that would figure into the solution of other local lake-related problems such as flood control, fish and wildlife habitat, and conservation. Thus, unique opportunities appear to be present to provide common solutions to various area concerns via an appropriate long-term dredged material management program.

To better discuss such potential programs, an understanding of other local conditions is helpful. Various natural landforms in the western Lake Erie basin provide important flood abatement and erosion control, thus protecting and enhancing commercial, residential, agricultural, and habitat resources. These would include dike systems and barrier beaches along the Ohio shoreline and Woodtick Peninsula on the Michigan shoreline.

## Logistics and Costs

A review of current operations indicates that with the use of hopper dredges, a significant portion of the current disposal costs of the lake channel material is the transport cost from the channel to the open lake disposal site. Use of the existing site apparently has had some negative effect on the local environment and the city of Toledo water intake. Future dumping might have to be moved to a location farther from the channel, and additional measures such as bringing the dredge to a full stop prior to discharge might

be necessary to minimize environmental impacts. These constraints will significantly increase open lake disposal costs.

Our preliminary findings indicate that to make the alternatives even more cost competitive, it may be necessary to consider alternate dredge methods from only the current hopper dredge to include consideration of a pipeline dredge. It may also require installation of a pipeline and pumpout platform from which a hopper dredge could pump the material to an on-land booster station for further pumping to an upland disposal area. As the material from the Toledo Harbor is composed primarily of light silt and clay particles, the material should be relatively easy to pump, and usable life of the pipeline should be relatively long.

To better facilitate such operations that might involve pipeline dredging or increased pumping from a hopper dredge, consideration should be given to completing maintenance under large contracts, perhaps at 2-year intervals. Minor dredging could then be accomplished by smaller dredges for annual maintenance. Another factor that could be considered is the deepening of the channel to provide more buffer between the necessary draft depth which would result in greater "storage" capacity. This would allow dredging contracts to only be awarded at 3-year intervals, resulting in further cost-savings.

## Other Benefits

The use of dredged material to enhance the area environment and to solve other problems will provide other economic benefits. For example, the reconstruction of Woodtick Peninsula would provide flood protection and erosion control that is urgently needed right now. The MDNR has estimated that when Woodtick disappears, the loss to fish and wildlife habitat will average $500,000/year in an existing, managed marsh area that is protected by Woodtick. Loss of similar habitat in the North Maumee Bay would be valued at over $1,600,000/year, based on CE valuation estimates. Losses to commercial and residential properties in the Woodtick Peninsula area would be in the millions of dollars due to anticipated flooding.

The use of dredged material to construct a recreational hill for support of winter sports activities could also result in a revenue-generating end use that would greatly enhance and expand the economy of the host community and the region. Such a site could also be used for summer water slides and be developed into an intensively used family recreational opportunity.

The consideration of alternate dredged material disposal methods offers an opportunity to enhance wildlife habitat, improve the quality of Lake Erie, reduce the destruction of existing fish and wildlife habitat, provide flood control, and create recreational areas. The reuse of dredged material as a topsoil or structural fill for area construction projects would, in a sense, return the soil to its origins.

## Long-Term Management

Long-term management methods will result in the least overall cost and provide the greatest enhancement to the area. Other than the construction of the recreational hill, no single alternative is likely to provide sufficient

capacity for a long-term solution. A combination of beneficial uses will be necessary. This will also necessitate flexibility in the type of dredging equipment used, the cooperation of two CE Districts (Detroit and Buffalo), and flexibility in contract dredging.

## The Next Steps

Three steps remain in our feasibility evaluation. Step 5 calls for review of the selected alternatives and the establishment of priorities if more than one beneficial use is selected. In Toledo, priorities will probably be in the following order: (a) the establishment of a commercial reuse operation to provide topsoil and fill material; (b) detailed investigation of Woodtick Peninsula restoration, including a demonstration project that uses a stabilized fly ash and cement mixture for diking and armor protection; and (c) a detailed investigation of upland reuse options such as the winter sports hill.

Steps 6 and 7 call for a detailed investigation and/or demonstration of the selected beneficial use and a full-scale implementation of the alternative.

## Development of NU-SOIL as an Alternative

Even at this stage of the study, we have proceeded with the investigation/demonstration of the reuse of material inside a CDF. In 1986, S&L Fertilizer, a company that has specialized in the farm application of wastewater treatment sludge, came forward and asked to participate in a study of dredged material reuse. The concept is that the dredged material would be removed from existing Toledo CDFs, and the available space would be resold to the CE and others requiring reasonably priced CDF space.

A demonstration project by S&L was sponsored by the Toledo/Lucas County Port Authority to create NU-SOIL, a combination of 94 percent dredged material, 4 percent wastewater sludge to add organic matter and enrich the soil, and 2 percent water treatment process lime sludge to control the pH and improve soil structure. The sewage sludge and lime sludge are spread onto the dry surface of the CDF; then they are disked into the soil. This process is repeated until the proper mix is achieved. Then the material is mechanically removed with a pan and stockpiled several months for curing.

The resulting NU-SOIL will sell for less than topsoil in bagged and bulk form. Plots of grass and landscaping have been established for demonstration and experimentation purposes. Each batch of material has been tested for heavy metals as well as nutrient value. S&L is satisfied that the product has a suitable market. In addition, untreated dredged material will be sold for subsoil and fill material.

The demonstration plots are small in comparison to the area needed for a commercial application of the process. The alternative sources of dredged

material are the current CDF and Island 18. Island 18 is preferable for several reasons, but it has a major liability in that it is an island with an old causeway that has been deliberately breached for small boat passage. Reconstruction of the causeway would cost about $750,000 with Baily bridges for small boat access. Funding is a problem but probably not a major obstacle.

The major stumbling block to the commercial development of NU-SOIL appears to be the inability of the CE to purchase space in a newly emptied CDF. Such a purchase can be made at a bargain cost in relation to the cost of construction of a new CDF, possibly as low as $1.75/cu yd versus $4/cu yd of newly constructed space. This is a key element to the economics of NU-SOIL and currently a missing link. The CE has been considering the possibility and has suggested an offer of about $0.30/cu yd. However, if the project is to be economically viable, a larger and more reasonable contribution will be required. The reality of other dredged material disposal practices such as open lake disposal in an environmentally acceptable manner is going to increase. At the very least, the CE can expect to have to examine stationary dumping, silt curtain turbidity controls, and most importantly, the dumping in low-energy zones. In order to establish a more realistic price for the CDF space created, the CE will have to take a longer-term view.

NU-SOIL represents an important alternative for the Toledo area because it solves several problems at once. However, NU-SOIL is not likely to utilize more than one quarter of the Toledo Harbor dredging each year, especially if regional markets are not found for the product. Other alternatives must also be implemented. These alternatives probably will also need creative action by the CE as well as by local sponsors.

## Conclusions

The Toledo Harbor has alternatives for dredged material disposal that appear to have environmental and other benefits beyond the traditional practices of open water disposal and in-water confinement facilities. However, they will require the support and enthusiasm of the CE to be realized. I would like to close with three constructive suggestions for the CE if it is truly interested in supporting and expanding the beneficial reuse of dredged material:

a. There must be a long-term strategy that incorporates creative thinking and innovative approaches. These are problems that are here to stay. The ideas of long-term management plans are the logical approach to this type of problem and will result in overall lower costs. In Toledo, we can even include source reduction of sediment as a part of the strategy. These plans should be required for each harbor. Any long-range plans must include the consideration of total capacity of the site over its total expected life. This will encourage a very low per-unit cost over a longer period of time.

b. Recognizing that the CE must follow the authority that is legislatively provided, it must work to achieve greater flexibility. Let me provide examples:

(1) There is a need for flexibility in the placement of non-hazardous polluted material in either CDFs or other reuse alternatives. In Toledo, the heavily polluted material is acceptable for land application options; therefore, mixing heavily polluted and moderately polluted material will not jeopardize the reuse program.

(2) Under current practice, material being dredged within 1 mile of a CDF would have to be transported 9 miles to an open lake disposal site because it is suitable for open lake disposal. With the advent of reuse of the material from the CDF, it makes little sense to haul the material to the open lake.

(3) We need flexibility in our need to obtain credit for our local sponsor-provided CDF space.

(4) We need flexibility in consideration of multiple use benefits as erosion control at Woodtick Peninsula.

(5) We also need flexibility in the dredging-program schedule to consolidate work efforts into larger jobs that would allow the economics of scale to apply for certain alternatives.

Effective plans for dredged material disposal will require more flexibility---either in policy or in law or both. We ask the CE to try harder to use the authority it has to support reuse alternatives. Where this is simply not possible, then let those of us who are seeking solutions help your agency. If the CE needs additional authority, we can work with our Congressmen on this.

c. Reuse must be given a fair and objective analysis in comparison to other alternatives. There will be problems to overcome, and they can easily be used as an excuse to eliminate reuse options. On the other hand, the traditional options of open water disposal and confinement must be honestly examined. The cost of silt curtains, disposal only in low-energy areas, stationary dumping, and other factors must be considered in any analysis.

The Toledo Metropolitan Council of Governments appreciates the opportunity to present our thoughts on the reuse of dredged material and we applaud the CE for convening this workshop. Thank you.

## SESSION V: THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES FOR BENEFICIAL USES

# BENEFICIAL USES OF DREDGED MATERIAL IN THE DEVELOPMENT OF TORONTO HARBOUR

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## Introduction

I want to outline from a Canadian perspective the determining factors associated with the general use of dredged material as well as the direct and indirect beneficial uses derived from dredging. I will also focus on Toronto Harbour as an example of how dredged material has been used to create a variety of land types and uses.

There are three factors determining use of dredged material in the Canadian Great Lakes: (a) environmental acceptability, (b) engineering properties and technical considerations, and (c) costs. Dredged material must be acceptable for unrestricted disposal, which includes meeting applicable guidelines for clean sediment. This aspect also takes into consideration public attitude and socio-economic factors. Sediment types, dredging plants, and disposal methods must also be considered. Costs are a primary consideration in beneficial uses and may be higher when compared to open lake disposal or other traditional methods.

There are also many indirect beneficial uses derived from the disposal of contaminated dredged material. This is generally in terms of potential commercial value of filled disposal sites which are usually located in the vicinity of regional ports and harbours.

## Categories of Beneficial Uses

There are generally five categories of direct and indirect beneficial uses accruing from disposal of dredged material. These are (a) recreational, (b) industrial and commercial, (c) waterway development, (d) land reclamation and improvement, and (e) habitat development. Dredged material containment areas, either alone or in combination with other developments, have often been the location of waterfront parks. The creation of lagoons, marinas and similar facilities, and new beaches, as well as beach nourishment of eroding beaches, has also been carried out using dredged material. The beach nourishment option is strictly contingent upon suitability of grain size and compatibility with existing beach material.

Filled areas along the waterways in Canada and in the vicinity of major ports and harbours, provide sites for industrial and commercial developments.

Dredged material is used for expansion of harbour facilities such as docks and piers and is by far the most common use of dredged material in Canada. In addition, dredged material, in keeping with intended long- and short-term recreational and commercial goals, has often been placed on waterfront sites for land reclamation.

Dredged material disposal sites located in the migratory flyways of waterfowl and other aquatic birds provide excellent avian sanctuaries and resting sites. Wetlands and fish spawning areas have also been created by judicious placing of dredged material.

A list of recent dredging projects in the Canadian Great Lakes (1975-1980) where either immediately or potential long-term beneficial use has been derived by the disposal of dredged material are included in Table 1.

## Formation of Toronto Harbour

Metropolitan Toronto (population 2.8 million) is located near the western end of Lake Ontario on the north shore. The Toronto Harbour is situated in the central waterfront region at the mouth of the Don River, one of numerous short rivers which drain into the western portion of Lake Ontario. The Don River drains an area of about 36,000 ha, and its headwaters extend approximately 35 km north of the lake.

Sediment brought down to Toronto Harbour by the Don River is the main cause for dredging in the harbour. The Don River, with a drainage basin of 475 sq km, carried down about 30,000 cu m annually in the preconstruction years (1940-1959), 120,000 cu m during 1960-1969 (Don Valley Parkway construction), and 50,000 cu m during postconstruction years (1970-1984).

Dredged material disposal prior to 1972 was in the open lake beyond the 17-m depth contour. From 1972 to 1974, dredged material was buried under sands dredged from the Outer Harbour development. As a test in 1975, dredged material was placed in a polder inside Hardpoint No. 5 of the East Headland; then the entrance was sealed off. In 1976 to 1979, only emergency dredging was performed for navigation at costs up to 25 times greater than before due to rehandling by trucks into the polder of Hardpoint No. 5. Since 1980, the dredged material has been placed in an endikement (CDF).

The Keating Channel at the mouth of the Don River was dredged on an annual basis between 1920 and 1974. Over this period, the maximum volume dredged was 173,500,000 cu m. Until 1964, this material was disposed of in open water south of the Toronto Island. Between 1961 and 1974, dredged material was used in the construction of the East Headland.

Dredging in the Port of Toronto has been undertaken both by Public Works Canada and the Toronto Harbour Commission. The main harbour channel through the Outer Harbour and the Eastern Gap are maintained to a depth of 8.8 m, as in the lakeward channel from the Western Gap. The main shipping area and the Western Gap have depths of 8.2 m.

The usual Toronto Harbour Commission dredging rig consists of a combination floating heavy lift crane supplied with a clamshell with a 2.7-cu-m bucket, two 191-cu-m bottom dump scows, and one or two tugs. Maps 1 through 4 show the evolution of Toronto Harbour.

Outer Harbour East Headland and Endikement

The East Headland has four significant components which have been created through the use of dredged material in combination with trucked fill. These components are the Outer Harbour East Headland, the Aquatic Park, the endikement, and the dredged material disposal cells.

Leslie Street Spit (Outer Harbour East Headland)

From 1961 to 1972, dredged material from Toronto Harbour was dumped in front of the advancing spit during construction of Aquatic Park. The dredged material was buried with other fill which was trucked in, and larger material was placed to stabilize the newly created peninsula in keeping with coastal engineering principles (Map 5).

In 1974, a reduced volume of dredged material was deposited on the spit due to a shortage of approved disposal sites. By that time, guidelines for open water disposal were in existence which prohibited open water disposal of the majority of material dredged from the harbour. Land creation through unconfined disposal of dredged material ceased. After 1974, dredging activity in the Keating Channel was curtailed due to the lack of suitable confined disposal sites, and only maintenance dredging of the Keating Channel mouth and slips were undertaken. Dredged material from these operations were incorporated within armoured hardpoints (rubble-mound dike) on the lakeward side of the Eastern Headland until 1980.

Aquatic Park

The Aquatic Park portion of the East Headland was created using trucked earth and rubble as well as sandy dredged material from the Outer Harbour-East Gap dredging operations in 1973 and 1974. Approximately 5 MCY of dredged material was disposed in 1973 and 3.5 MCY in 1974. A total of 162.8 acres of land was created. The area is now called the Tommy Thompson Park and is designated as an environmentally significant area by the Metropolitan Toronto and Regional Conservation Authority. The area is now host to a wide variety of wildlife and possesses a wide range of vegetation cover and land use types (Map 6).

The Endikement

The construction of the endikement began in 1979 on the south side of the East Headland using trucked fill to provide a disposal site for Inner Harbour dredged material. Dredging of Keating Channel stopped in 1975. Limited navigational dredging did continue, and this material was placed in hardpoints located on the East Headland. Between 1976-1979, emergency dredging of the harbour was performed for navigational purposes. Since 1980, dredged material has been placed in the endikement.

The endikement was designed and constructed to enclose dredged material and to realign the Outer Harbour East Headland for armouring against waves. The core of the endikement dikes consists of fines; the exposed edges are hardpoint-anchored pebble beaches that are heavily supplied with rubble. The endikement is located in 33 to 52 ft of water and forms three cells of 0.28-, 0.53-, and 2.2-MCY volumes, respectively.

Originally the cells were constructed to afford lake access by tugs and scow. Each cell was constructed with an entrance containing a sill and narrowed to reduce dredged material migration out to the lake while still allowing transit of tug and scow. The next-to-receiving cell acted as a wave-stilling effect. Disposal of Keating Channel and Inner Harbour sediment in the endikement cells (Cell No.1) began in late 1980. The cells remained open to the lake between their construction in 1979 and August 1987 when Cell No.3 was closed to Lake Ontario (Map 7).

### Dredged Material Disposal Cells

Dredged material exceeding open water disposal guidelines is placed in the containment cells of the endikement. Cell No.1 is the innermost of the three cells and was filled 1.5 m deep in 1985. The actual amount of dredged material placed in Cell No.1 was 365,441 cu m. Cell No.2 has an estimated capacity of 530,000 cu m. Placement of dredged material began in 1985, and the cell currently contains 214,000 cu m of sediment.

The capacity of Cell No.3 has been estimated as 2,200,000 cu m. No material has been placed in this cell yet, and its lakeside entrance is currently closed (and consequently lake access to all cells is closed). The transport of dredged material through to the cells is via a cut through the East Headland. Barges now enter Cell No.3 via an access channel through Aquatic Park and the Headland, which connects the Outer Harbour with Cell No.3.

### Beneficial Uses

The beneficial uses obtainable from dredged material at the East Headland and endikement in the Toronto Harbour are as follows. Aquatic Park is a designated environmentally significant area possessing a variety of wildlife, land-use types, and vegetation. The Leslie Street Spit and East Headland afford access to Aquatic Park as well as possessing potential for recreational use. The potential beneficial uses of the endikement and the three cells are being discussed, but the ultimate use must be compatible with the recreational and habitat uses of the adjacent areas (Map 8).

## Conclusions

In conclusion, it can be stated that whenever dredged material is used in the creation of land either through the construction of confined disposal facilities or in combination with landfilling (trucked fill), the potential for development of recreational and wildlife/recreational areas exists. However, with this alternative comes the necessity for one to ensure that

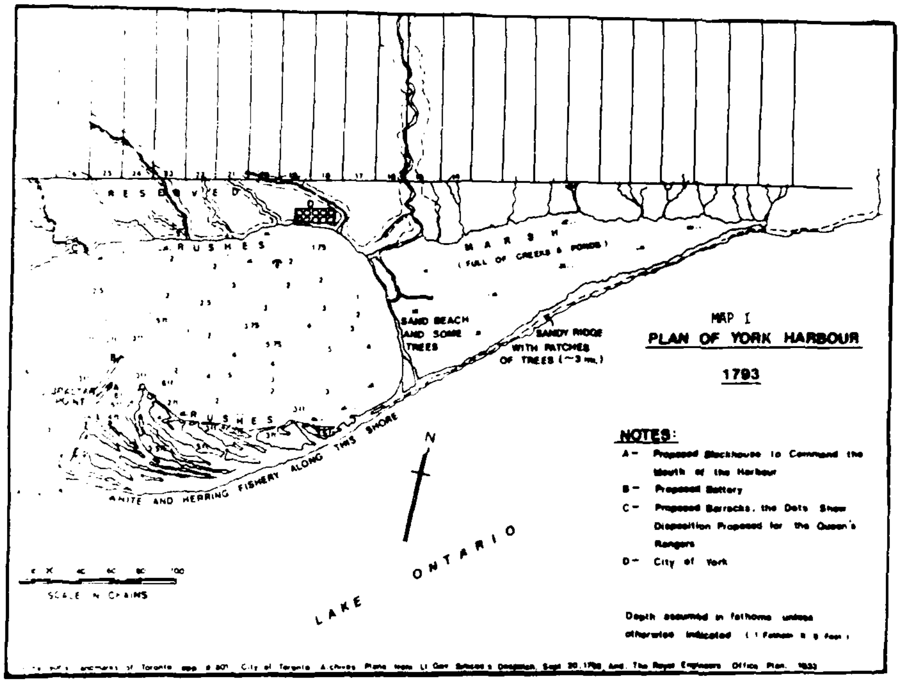
long-term management strategies are in place. Stewardship (responsibility) of the option chosen must be incorporated into the decision-making process. An agency or organization cannot commit to an option without realizing that the decision involves long-term management.

I could recommend that the opportunity for beneficial uses be incorporated into all decisions relating to the placement of dredged material, but it appears to me to be inevitable that the majority of disposal options in and of themselves lead to a beneficial use. All that is needed is to optimize that use through proper planning, design, and management.

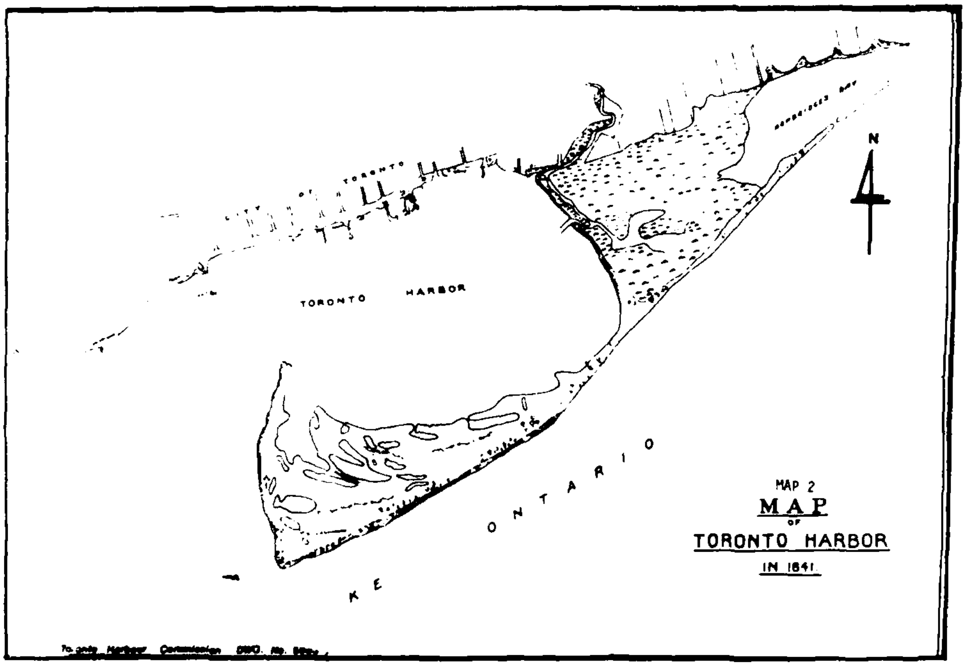
Table 1

Beneficial Uses of Dredged Material in the Canadian Great Lakes, 1975-1988

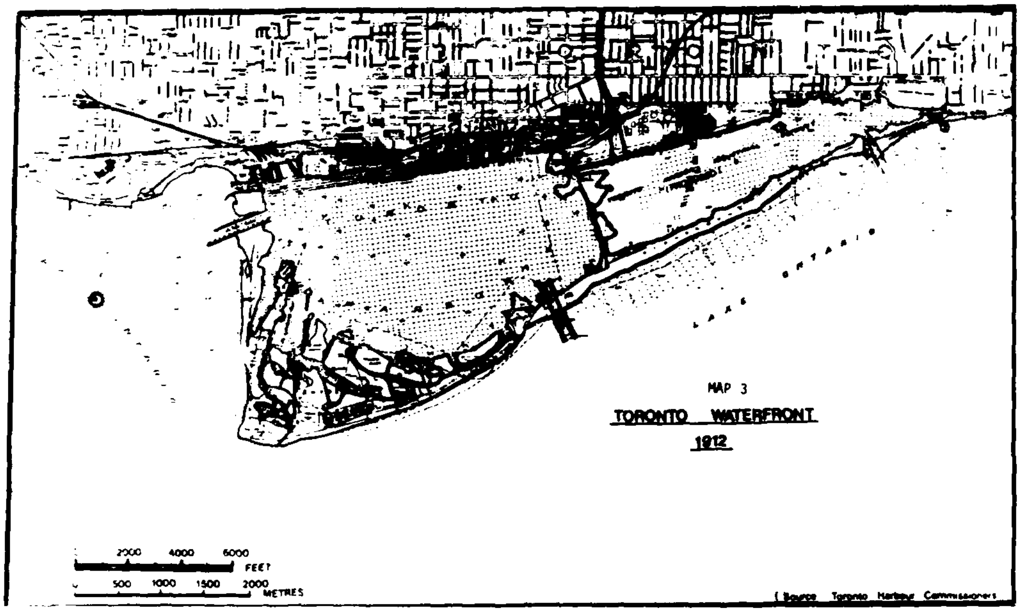
| Location | Date | Quantity, cu m | Beneficial Use |
|---|---|---|---|
| Lake Superior | | | |
| Thunder Bay Disposal Facility | 1978-1988 | 5,000,000 | Waterfront Park |
| Lake Huron | | | |
| Grand Bend | 1975 | 10,000 | Recreation |
| Goderich | 1979 | 72,000 | Recreation |
| Port Elgin | 1978 | 7,800 | Reclamation |
| Lake Erie (Lake St. Clair) | | | |
| Little Current | 1981 | 36,000 | Reclamation |
| Kingsville | 1978 | 39,732 | Reclamation |
| Mitchell's Bay | 1979 | 5,780 | Reclamation |
| Pike Creek | 1977 | 19,600 | Reclamation |
| Port Stanley | 1978 | 169,000 | Reclamation |
| Port Stanley | 1979 | 20,000 | Waterfront Park |
| Port Stanley | 1980 | 55,000 | Beach nourishment |
| Puce River | 1978 | 11,142 | Reclamation |
| Ruscom River | 1978 | 28,410 | Reclamation |
| St. Clair Parkway Comm. | ---- | 30,000 | Marina |
| Lake Ontario | | | |
| Hamilton | 1978 | 120,000 | Pier development |
| Oshawa | 1978 | 60,000 | Industrial |
| Oshawa | 1979 | 40,000 | Industrial |
| Oshawa | 1982 | 10,000 | Industrial |
| Port Credit | 1976 | 4,700 | Reclamation |
| Toronto | 1970-present | 40,000-50,000 annually | Recreation, industrial, habitat development |
| Whitby | 1978 | 188,300 | Recreation, reclamation |
| Trent-Severn Waterways | 1980 | 10,000 | Habitat development |



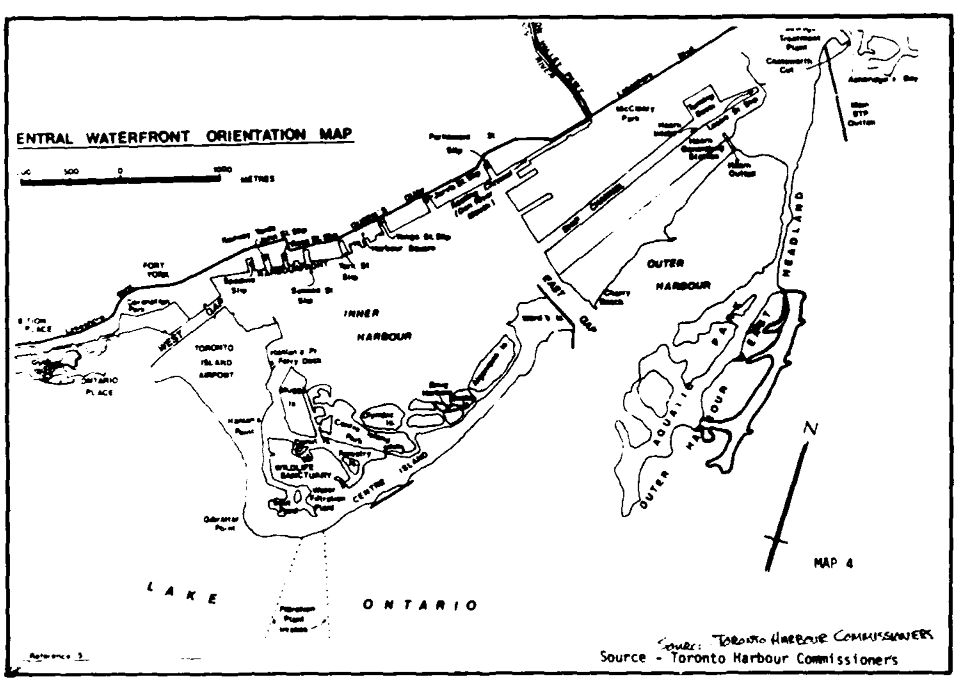

Map 1. The plan for city of York Harbour in September 1793, filed in the archives of The Royal Engineers Office, city of Toronto, Ontario, Canada



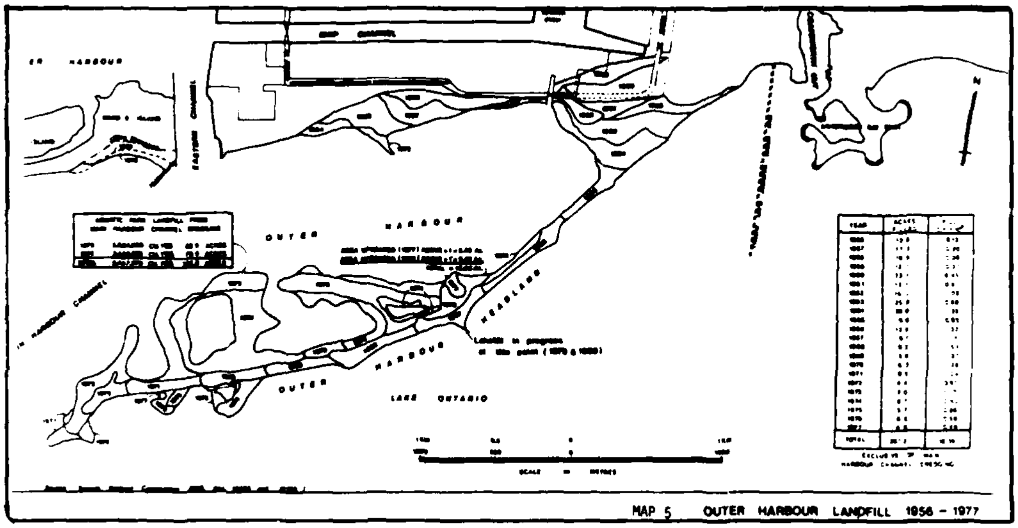

Map 2. The plan for the city of Toronto Harbor in 1841 from the Archives of the city of Toronto, Ontario, Canada



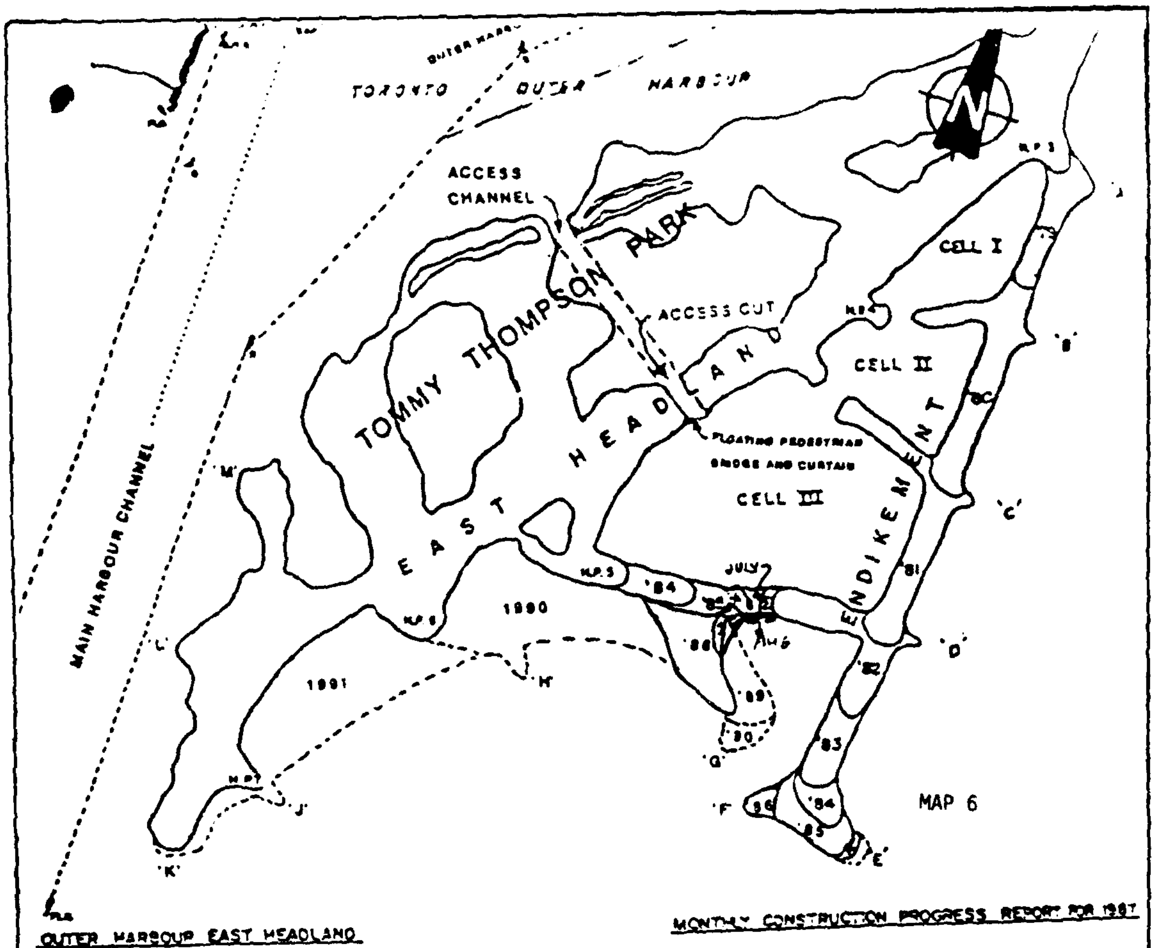

Map 3. The plan for Toronto's Waterfront in 1912 from the archives of the city of Toronto, Ontario, Canada




Map 4. The central waterfront orientation map for the Outer and Inner Harbours of the city of Toronto, Ontario, Canada



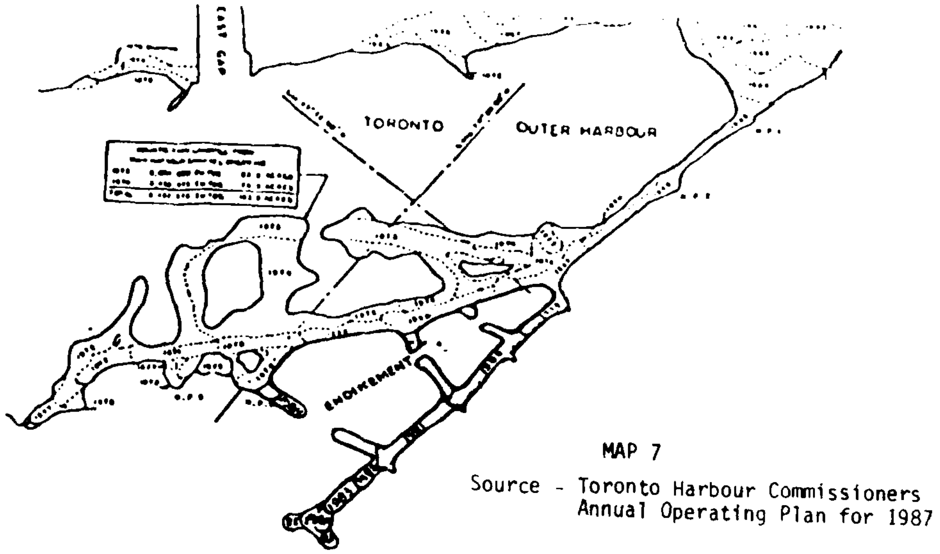

Map 5. A schematic of the Outer Harbour landfill showing years of completion, acres built, and location of dredged material deposits




| MONTH | TRUCK LOADS | CUBIC METRES | DREDGE SPOIL cm | TOTAL cm | ha | REMARKS |
|---|---|---|---|---|---|---|
| Jan/87 | 4,064 | 34,275 | - | 34,275 | 0.09 | |
| Feb/87 | 6,179 | 52,082 | - | 52,082 | 0.21 | |
| Mar/87 | 2,380 | 19,040 | - | 19,040 | 0.24 | |
| Apr/87 | 3,155 | 25,240 | - | 25,240 | 0.16 | |
| May/87 | 3,411 | 27,288 | - | 27,288 | 0.01 | |
| Jun/87 | 4,236 | 33,888 | 11,460 | 45,348 | nil | |
| Jul/87 | 10,583 | 85,204 | 10,123 | 95,327 | 0.59 | |
| Aug/87 | 4,958 | 39,664 | 17,572 | 57,236 | 0.06 | |
| TOTALS | 38,966 | 316,681 | 39,155 | 355,836 | 1.36 | |

Source - Toronto Harbour Commissioners Annual Operating Plan Monthly Progress Report August 1987

Map 6. The monthly construction progress report for 1987 for the Outer Harbour East Headland, where dredged material fill was used to develop a multipurpose complex of parks and other beneficial uses



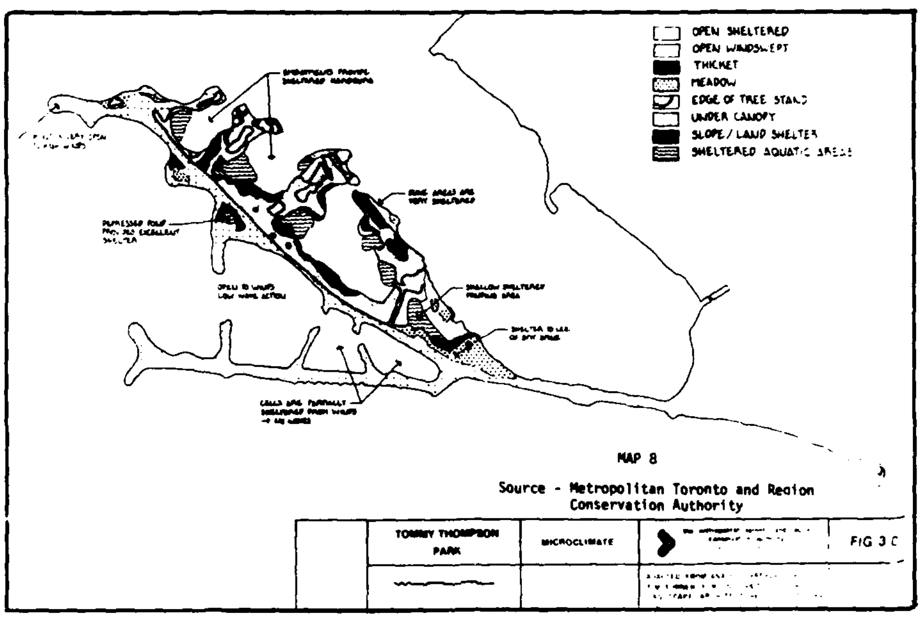

MAP 7

Source - Toronto Harbour Commissioners
Annual Operating Plan for 1987

**OUTER HARBOUR EAST HEADLAND** **PROGRESS REPORT FOR YEARS 1956–1986 INCL.**

| YEAR | TRUCK LOADS | CUBIC METRES | DREDGE SPOIL m | TOTAL m | ha | REMARKS |
|---|---|---|---|---|---|---|
| 1956 | 26,000 | 99,385 | - | 99,385 | 5.50 | |
| 1957 | 38,000 | 149,078 | - | 149,078 | 7.00 | |
| 1958 | 13,894 | 58,867 | - | 58,867 | 6.68 | |
| 1959 | 78,901 | 283,630 | - | 283,630 | 4.90 | |
| 1960 | 107,880 | 347,542 | - | 347,542 | 9.35 | |
| 1961 | 123,704 | 390,277 | - | 390,277 | 4.90 | |
| 1962 | 114,725 | 408,702 | 416,653 | 825,355 | 6.47 | |
| 1963 | 156,820 | 522,536 | - | 522,536 | 10.12 | |
| 1964 | 266,826 | 1,034,904 | - | 1,034,904 | 15.78 | |
| 1965 | 173,912 | 705,834 | - | 705,834 | 3.64 | |
| 1966 | 180,561 | 757,620 | 252,285 | 1,009,905 | 4.86 | |
| 1967 | 180,700 | 779,790 | 99,385 | 879,175 | 3.92 | |
| 1968 | 238,918 | 1,110,482 | 77,054 | 1,187,536 | 3.72 | |
| 1969 | 178,451 | 902,822 | 143,126 | 1,045,948 | 2.27 | |
| 1970 | 184,600 | 893,067 | 82,310 | 975,377 | 2.55 | |
| 1971 | 199,501 | 910,514 | 66,397 | 976,911 | 3.44 | |
| 1972 | 157,921 | 690,835 | 51,650 | 742,485 | 1.78 | |
| 1973 | 169,850 | 768,490 | 74,002 | 842,492 | 0.81* | |
| 1974 | 98,797 | 458,321 | 22,505 | 480,826 | 3.52** | |
| 1975 | 106,514 | 610,725 | 44,100 | 654,825 | 2.31 | |
| 1976 | 78,817 | 451,917 | - | 451,917 | 2.75 | |
| 1977 | 64,402 | 369,265 | 3,662 | 372,927 | 1.86 | |
| 1978 | 16,496 | 94,584 | 13,341 | 107,925 | 0.16 | Rubble only 78/1/19 |
| 1979 | 76,254 | 437,224 | 3,392 | 440,616 | 2.29 | Endikement 79/4/2 |
| 1980 | 182,797 | 1,040.719 | 43,045 | 1,083,764 | 4.30 | |
| 1981 | 182,616 | 1,438,131 | 102,875 | 1,541,006 | 3.50 | |
| 1982 | 157,065 | 1,216,345 | 73,010 | 1,289,355 | 2.88 | |
| 1983 | 113,702 | 895,430 | 29,760 | 925,190 | 1.62 | |
| 1984 | 100,636 | 779,303 | 83,335 | 862,638 | 1.78 | |
| 1985 | 98,067 | 689,565 | 83,214 | 772,779 | 1.91 | |
| 1986 | 91,967 | 744,303 | 62,455 | 806,758 | 1.70 | |
| TOTAL | 3,959,294 | 20,040,207 | 1,827,556 | 21,867,763 | 128.74 | |
| * '73 | | | 3,825,558 | | 33.55 | Aq. Pk. Main Harbour |
| ** '74 | | | [illegible] | | 32.3[illegible] | Channel Dredging |

Map 7. The progress report for 1956 through 1986 for construction at the Outer Harbour East Headland in Toronto Harbour, where dredged material was used to develop a multipurpose complex




Map 8. A habitat inventory map for Tommy Thompson Park in the Toronto Harbour complex that was built of dredged material

# GREETINGS FROM THE WESTERN DREDGING ASSOCIATION

Eric H. Seagren
Ellicott Machine Corporation
St. Louis, Missouri

Thank you, Dr. Jahn. As a member of the Board of the Western (Hemisphere) Dredging Association, I bring you our greetings and want to let you know that we are fully behind the search for beneficial uses of dredged material and what you are doing. Our worldwide sister organizations are the Eastern Dredging Association and our European/African Association. We meet annually and are the only professional and technical organization in North America dedicated to advancement of dredging technology and marine construction.

I had a US Army General tell me that dredging will become acceptable in the eyes of the public when his son could go to the store and buy a model of a dredge! You people are bringing that closer to reality, and I am very impressed. I have also been impressed as a member of industry that you have challenged us to make changes in dredging equipment and technology. You are asking us to pump further distances, come up with special placement requirements, and handle contaminated sediment. Well, we can do that, and we will with your help.

Everytime I talk to ports and groups having to dredge, they ask me what they can do to cut dredging costs. Well, I see beneficial uses as a way to help out these cost-sharing partners because they can get something back for the costs they put in if they will take advantage of beneficial use opportunities.

In closing, I want to let you know that the World Dredging Conference will be held in Orlando, FL, in May 1989. It is our first meeting in the US in 6 years, and the theme will be "Go for the Magic in Dredging." I hope to see you there. I am excited about this, and I am excited about the magic I see you people generating here at this workshop. Keep up the good work!

## BREAKOUT GROUP TECHNICAL RECOMMENDATIONS AND CONCLUSIONS

### AQUATIC HABITATS

Robert Barber and Robert L. Lazor, Session Co-Chairmen

Our breakout group addressed a number of questions dealing with aquatic habitat beneficial uses of dredged material. The consensus of opinion from the group is as follows:

a. Existing CE legal and policy guidance is presently adequate to pursue this disposal option.

b. Other Federal, State, and local guidance should be examined to determine its applicability for beneficial uses of dredged material.

c. The concept of long-term management strategies for dredged material is compatible with aquatic habitat beneficial use applications.

d. We should seek early on to identify the applicability of the Federal standard to aquatic habitat beneficial options.

e. There is presently no need to prioritize aquatic habitat development with dredged material for a specific project authorization, rather this option may be considered for navigation, recreation, flood control, and other projects as well.

f. Interagency cooperation is the key to successful projects and may lead to cooperative funding agreements between agencies.

g. Fine-grained sediments should be given equal consideration with coarse-grained sediments for aquatic habitat use. Special methods such as capping of contaminated sediments may allow a wider range of aquatic habitat applications.

h. We believe 90 percent of all dredged material is suitable for multimedia disposal.

i. We see a need for monitoring man-made aquatic habitat sites to determine whether or not they are successful and what can be done to improve them. We also see a need for site-specific or regional evaluation of the potential for aquatic habitat development using dredged material.

j. We feel that there is definitely a need for more research in this highly sensitive habitat development arena and would like to see ideas brought out in this regard.

k. We recommend the use of local demonstration projects where feasible to break down the resistance of citizens and cost-sharing partners over the concept of aquatic habitat development.

l. We feel that a stated policy from resource and regulatory agencies dealing with aquatic habitat development to smooth the way for future work should be determined and made public.

m. Endangered species are a special concern, and aquatic habitat development that would enhance these organisms should be carried out as often as possible.

n. The group sees a great need for closer coordination with all agencies and parties concerned over the use of dredged material for aquatic habitats.

COMMENT (MR. McGREGOR): I was in this group and wanted to comment on my thoughts from last night. For the full potential of beneficial uses of dredged material to be realized, agencies must review and change their policies. I am a CE regulator, and my observation is that many of the resource agencies that make regulation and policy statements that deal in absolutes and prohibitions in the name of upholding the Public Trust are actually violating that Public Trust by taking themselves out of the game. When we prohibit alternatives and ideas and establish criteria that deal in absolutes, we are taking ourselves out of the solution to the problem as regulators. To me, that is a violation of the Public Trust. The expertise, experience, knowledge, and judgement embodied in Federal and State employees to address the problem, is as much a part of the Public Trust as the material you are dealing with. I wanted to be sure that comment was on the record because I believe all regulatory bodies are going to have to review their positions and policies and philosophies in order for us to get on with solutions to the problems.

## BREAKOUT GROUP TECHNICAL RECOMMENDATIONS AND CONCLUSIONS

### HABITAT DEVELOPMENT CASE STUDIES

Hollis H. Allen and Bruce Stebbings, Session Co-Chairmen

In our breakout group, we started with some specific problems and issues such as vegetating sterile sandy dredged material to more general issues such as followup workshops. I believe we came up with some valid questions and recommendations, as follows:

a. How can we best vegetate coarse-grained sandy dredged material along the TTWW, Apalachicola River, Black Warrior River, and numerous other rivers that have great quantities of sandy sediment being placed in disposal sites?

We recommend that each case like the above should be evaluated from a site-specific standpoint. Before too much money is invested, we also recommend trying a pilot study to see which methods work best. Essentially, this is what we saw Rock Island District do in the Upper Mississippi River on some dredged material islands.

b. Can we, using the interior least tern as an example, develop informal or formal cooperative relationships among the CE and other Federal and State resource agencies to develop plans that will serve to protect or enhance a resource (i.e., the least tern) in a way that is mutually acceptable to all?

Our group felt that the answer is yes and that there is a precedent for something similar to this in the Upper Mississippi River where an On-Site Inspection Team has been formed by the CE and other agencies to examine areas for the best potential disposal sites and use of the sites. A formalized, signed agreement by various agencies effected this cooperation. Our group also noted that in their experience, informal cooperation on the local level often has just as good or better results without the red tape.

The suggestion was made that a local landowner representative be included on interagency teams. For example, Alabama landowners are forming a River Bottoms Landowners Association. Landowners want to know what is being done on rivers and waterways adjacent to and on their property. Some landowners are willing to have dredged material placed on their property.

c. A non-CE participant mentioned that the CE has taken the lead through workshops such as this to effect interagency cooperation regarding the beneficial uses of dredged material, and he thought that the CE should continue to do this.

The group agrees and recommends that the CE should continue, perhaps by using WES to go to the Districts represented here and ask them what their interagency involvement has been and what the critical elements are that made their cooperative efforts successful (or unsuccessful).

d. The group perceives the new non-CE cost-sharing requirements under the WRDA to be a problem in terms of coming up with additional funds for project work, especially the money to devote to beneficial uses such as habitat development. It is going to be difficult in light of austere State and local budgets and a huge Federal budget deficit to do anything other than dispose of dredged material in the least costly manner. Exceptions may be when it comes to protecting or enhancing endangered species and their habitats or where beneficial uses can be used for a critical purpose such as shoreline stabilization in the community. Cost-sharing is frequently project specific, and this especially causes problems for local sponsors without a large funding base.

The group recommends that the CE should continue to better inform all agencies and private interests of the inherent values or potential values of dredged material and to encourage broader uses of all types (habitat development, restoration, preservation, industrial/commercial, recreation, agriculture, aquaculture, etc.). This should aid in convincing local, State, and other Federal sponsors that they will in fact often save project costs by incorporating beneficial uses into their project. In short, better public relations and better marketing of the resource are needed.

e. The entire group agreed with the idea of having a workshop of this nature and thought it was a valuable contribution toward addressing the dredging issue. They thought it would be good to hold an inland waterways beneficial uses workshop every 2 to 4 years. In the interim, we need to zero in on specific subjects such as wetland/upland habitat development in specific geographic regions with tailored 1- to 2-day workshops or seminars.

# BREAKOUT GROUP TECHNICAL RECOMMENDATIONS AND CONCLUSIONS

## INNOVATIVE USES AND CONCEPTS

Charles R. Terrell and Thomas R. Patin, Session Co-Chairmen

Since leaving EPA's 404 Program 8 years ago and moving to the SCS, I have had to learn a lot. I've learned how to drill beans, how to inject fertilizers, how to contour strip cropping, how to grass bank terraces, and a host of other things. It's all been very useful to me, and I wanted to leave you with the knowledge that these cram sessions we have had this week have been a refresher course for me. I've really heard and learned a lot. We have seen techniques and innovations and discussed them, especially last evening in the breakout group.

Eric Seagren stole my thunder earlier this morning because what I had intended to do was compare innovations and new technological advances in agriculture in the 1960's and 1970's to what is going on now in navigation and flood-control dredging work. Larry Jahn said it too---agriculture came out of the dark ages about 20 years ago, and there are now $75,000 to $100,000 tractors working land with 24-row planters and cultivators in place of a dozen smaller tractors and laborers. Admittedly, many farmers are finding themselves in an economic bind because of expensive equipment, but nevertheless agriculture made the transition. Older technology will not suffice to sustain this nation and world. The dredging industry has to make the same decision and move forward toward more innovative, more efficient dredging plants and placement capabilities.

We learned about dredging to fill areas for homes, highways, airports, ports, and industry. We learned about dredging to create wave protection and beach nourishment with underwater berms. We learned how to use dredged material for enhancing agricultural land. We learned about capping contaminated material, and about restoring strip-mined areas. One of our group last night brought up filling in old underground mines with dredged material. We learned about wetlands development and enhancement and restoration. We learned about protecting archaeological sites by covering them with dredged material, and about finfish and shellfish habitat development and enhancement. We learned that we can build endangered species habitat using dredged material. We can reestablish nongame species into areas by planting dredged material with food plots. We can reestablish native grasses and plants and save eroded banks and shorelines. We have surely heard about a lot of beneficial uses this week!

Maybe, if you are like me, we can't even digest it all yet. I know I have to think about all the new beneficial uses and ideas to which I have just been introduced and how it will apply to my own work and my agency's work. I suspect you are all thinking along these same lines.

One thing is clear to me from these papers and from our session last night, and that is that we have to do long-term planning. Maybe SCS can offer you some help in this area with our experience with conservation planning that

is part of our own long-term plans. It tells the farmer, rancher, or landowner that we are there for the long haul and tells them what they will be doing over the next 5 to 15 years. These plans are signed on the dotted line and approved by the local SCS Conservation District. That puts everyone concerned on the correct course for conservation improvements.

Long-term plans must be developed among all agencies and parties concerned for dredging activities. Then there are no surprises, and everyone knows what and when and how things are going to happen. Maybe we should concentrate on this for the next few years as we continue in the arena of beneficial uses.

I would like to add a comment to our group's primary recommendation, and that is the English lesson of the day---the $1.50 word I heard this week is "terrestrialization." That is a Big Word, and yet I knew exactly what the guy was talking about when he said it. The King's English is changing to meet new needs, and that is what those of us in Federal, State, and local agencies and organizations are going to have to do over the next few years.

What needs are out there? How can we meet them? Our language is changing. The question is, "are we"? Are we ready with new innovation and new technology?

Do you look at problems as constraints on the way you operate yourself and your profession, or do you look at them as opportunities and innovative chances? That is the question you have to ask yourself every time somebody comes to you with a problem. If I have learned anything in SCS, it is that there are no problems, just opportunities. What does "innovation" mean? To me, it means new, inventive, farsighted.

Bill Murden would like to see at least one beneficial use introduced into every dredging project that the CE takes on. You ought to give that serious consideration. When you look at your projects and ask, "What have I done to benefit the resource and to benefit the taxpayer," and you see that you have done the same old things, maybe you should look harder for ways to benefit. Don't be a naysayer.

I would like to leave you with a puzzle to illustrate our point (hand illustration). If the objective is to connect the dots in my puzzle with four straight lines, how are we going to do it? You have to psyche yourself into NOT being boxed in---not being in a rigid mind set---or you cannot complete the puzzle. Likewise, you cannot be innovative or creative if you have a rigid mind set, and so often, THIS is what we have to battle in government agencies, local and private groups, and in dealing with public resources.

## BREAKOUT GROUP TECHNICAL RECOMMENDATIONS AND CONCLUSIONS

### RECREATIONAL, COMMERCIAL, AND INDUSTRIAL APPLICATIONS

H. Roger Hamilton and George W. Johnson, Jr., Session Co-Chairmen

This week we have seen many fine examples of using dredged material for recreation, commercial, and industrial uses. We have seen them on a field trip; we have seen a lot of slides and a lot of data. We have heard illustrations in formal sessions and, informally, in breakout groups and at breaks and meals. A few things have become very clear to us.

We recognize that there are many differences that exist in the capabilities to accommodate beneficial uses across the US for one reason or another, and some of these have been mentioned. For example, differences in soil types and precipitation result in differences in vegetative characteristics of each region. In addition to the physical and biological differences, there are institutional differences as well. There are jurisdictional problems that have been discussed and many that have not been discussed.

Questions arise, such as who owns the material, who pays for its removal and its placement, how much can we pay or are we willing to pay incrementally above a base cost to dredge so that the beneficial use can be achieved? Beneficial uses may cost more than a basic dredging operation. Who pays for that difference? How much can we pay? What are some of the cost-sharing implications?

In addition to some of those differences in various regions, we have observed that interdisciplinary planning and management are not only nice-to-have but absolutely essential if the optimum results are to be achieved. Engineers, biologists, architects, landscape architects and planners, and a variety of other disciplines must be involved to reap the synergistic effects of all that talent and translate it into a beneficial and optimum use of dredged material.

Another important point is that those planners, managers, and team members must represent their agencies at various levels. This is especially true with institutional arrangements and negotiations that are generally a part of dredged material placement and use.

Our nation is rapidly urbanizing; we recognize that. Population dynamics are shifting all around the US. Various regions have their own cultures and their own value systems. With the mobility of people caused by the migration from the frostbelt to the sunbelt, those cultures move around and sometimes come into conflict. That translates into differences in perceptions, needs and demands, values, and expectations of what the public might expect from public operations and expenditure of taxpayer dollars. We don't know what all those expectations are. We certainly do not know what they mean in terms of customer satisfaction, but we need to find out, and we need to be aware that they are changing. We also have to be in a position to respond to them and to be flexible. These cultural and value differences translate into differences

in how we satisfy our customers, how we deliver our products, and how we are allowed to use public funds.

We had a very active session last night and a very good attendance. However, I could not help but notice that it was dominated by CE attendees, so what I am about to pass on in the way of recommendations may have some bias towards what we see in the CE as room for improvement. I think we all can recognize the applicability to other Federal agencies and other levels of government as well as to the private sector. Please bear in mind, however, that some bias might exist. Our recommendations follow:

a. Those of us in our session acknowledged that we may not be aware of all the existing authorities that allow us to do what we do with dredged material. Therefore, our first recommendation was to explore that arena and to find out what the current authorities are. We also recommend that the limitations of project activities be investigated and that we find out what our basis for operation is when we talk about the use of dredged material for recreation, commercial, and industrial development.

b. A second recommendation dealt with the need for flexible guidelines, not rigid or strict regulations, that would enable field personnel to respond to regional and local needs. We have a tendency sometimes to try to solve very difficult and complex problems on a national scale rather than with simple, straightforward regulations or solutions at a more regional or local level. The broad national scope sometimes does not work. We have to be able to respond to changing dynamics, needs, values, and cultures. We have to develop and maintain the ability to make decisions at the lowest possible level within an agency and within the framework of some overall guidelines acceptable on a national level. We pinpointed seven specific items under this recommendation:

(1) Ownership of the resource and of its use.

(2) Qualifications of the beneficiary of the dredged material use (should be the public and not a private individual or group).

(3) Require that the beneficiary provide a master plan or design for the long-range, "multiple-uses"? use of the material and the disposal site.

(4) Set up a hierarchy of values established for various uses that can be made of the dredged material resource. This will vary geographically and maybe even within the same watershed or region.

(5) Provide for design criteria flexibility to fit the capabilities and needs of non-Federal cost-sharing partners.

(6) Provide for public access to recreation areas along rivers where dredged material has been used to develop those recreation areas even if access must cross private land.

(7) Beneficial uses should be encouraged in all dredging projects where they are feasible, and any dredging guidelines should be biased in that direction.

c. Our third recommendation is to involve cost-sharing partners and other agency interests in the planning process at an early stage. Explore the means for the local sponsors to accept dredged material as part of their cost-share and recognize those contributions toward meeting their cost-sharing requirements.

d. We should explore ways to find incentives for cost-sharing sponsors to move and use dredged material themselves. This would relieve the CE of that burden, and there might be fixed incentives associated with this such as sale of dredged material for topsoil or other uses.

e. One of our group suggested that when train cars bring coal from the strip-mined areas to Lake Erie, they return full of dewatered dredged material to be used in strip mine reclamation rather than returning to the mines empty. When I worked for the Ohio Department of Natural Resources from 1959 to 1965, that idea was being discussed. Nothing has ever come of it, and it is still a good idea. There needs to be a mechanism and some communication and effort put into developing this idea to determine its feasibility.

f. We recognized that there are a lot of recreational sites built on dredged material throughout the US. We intuitively know that there are a lot of money and a lot of benefits being accrued regionally and in the nation as a whole by this type of use, but we don't know how much. Sometimes it takes a great deal of flexibility to develop such areas, and we all tend to think by a set of rules. I fear that we often are driven by rules and forget that rules are developed and implemented to help get the job done rather than hinder us. We have rules and laws and regulations, and we have to abide by these, and we often think nothing can change---don't you believe it! Rules and laws can be changed if they are for the public good. However, one needs to have a data base on which to base rule and law changes, so we recommend that each of us in our respective agencies get a handle on the magnitude of economic impacts associated with recreation developments that result from dredging operations.

g. What are the benefits that are accruing from these beneficial uses? What are the values involved? What does this mean in terms of dollars or some other measurable, trackable quantitative term? We need to find out more about identification and measurement of beneficial uses of dredged material.

h. Again, from the CE perspective, the group felt that it needed a commitment from the Office, Chief of Engineers to devote some more funds to beneficial uses where the beneficial use may cost more than a traditional dredging project. Some flexibility is needed at higher levels in Districts, Divisions, and in the Chief of Engineers Office which will allow District project managers to routinely make beneficial use of the dredged material. Some mechanism needs to be

available which will allow funds to be available from operations and maintenance budgets to meet beneficial use opportunities so that the project benefits will not be foregone.

*i*. Our last recommendation, but certainly not our least one, is that beneficial uses of dredged material should be a stated and written objective of the Chief of Engineers.

COMMENT FROM AUDIENCE: You shouldn't be so restrictive on the private developer if he is willing to pay his share of dredged material placement and re-use.

## BREAKOUT GROUP TECHNICAL RECOMMENDATIONS AND CONCLUSIONS

### THE GREAT LAKES AND THEIR UNIQUE OPPORTUNITIES

David C. Cowgill and M. William Newstrand, Session Co-Chairmen

The Great Lakes breakout group had 20 people attending with representation from Detroit, Buffalo, Chicago, and North Central CE offices; the Minnesota Department of Transportation; the Michigan and Ohio Departments of Natural Resources; the Toledo Metropolitan Area Council of Governments; the EPA Region V; Environment Canada; WES; and a consulting firm. We had fairly intense and lively discussions on a variety of questions and have a consensus of opinion on the following 14 recommendations we would like to see examined. These vitally concern beneficial uses and their continued application in the US and Canadian Great Lakes.

a. Long-term management plans should be developed for Great Lakes harbors that would encourage appropriate beneficial uses of the dredged material.

b. Disposal options should be evaluated as a function of the quality and nature of the material, and the selected alternative should consider the benefits derived from that alternative.

c. An ecosystem approach should be used when evaluating dredging and disposal alternatives at Great Lakes harbors.

d. Provisions should be made to allow for monetary compensation to a local sponsor for extending the life of an existing CDF, especially where placement sites are limited and expensive.

e. Since "beneficial uses are in the eye of the beholder" and are often subject to the values of the project manager or evaluator, the use of the onsite inspection-team concept developed in the GREAT program is recommended to arrive at an appropriate consensus.

f. Since the quality of previously disposed dredged material can change over time, beneficial reuse alternatives for CDFs should be evaluated based upon the current quality of the material.

g. In-water dredged material placement alternatives that could reduce the need for future dredging or reduce erosion of nearby landforms, such as the strategic placement of underwater berms, should be considered in Great Lakes projects.

h. Nourishment or refurbishment of natural habitats, or those previously constructed with dredged material, that are being eroded or destroyed, should be considered as a disposal option; i.e., beach nourishment, wetland restoration, or shoreline stabilization.

i. Some determination should be made as to whether contaminant uptake by terrestrial and aquatic organisms is occurring at CDFs and other confined areas during the operational phase of the facility or after its closure.

j. If uptake of contaminants is occurring to an unacceptable extent at CDFs, efforts should be made to minimize the exposure and uptake of these contaminants through management practices.

k. CDFs should be managed to minimize environmental impacts.

l. Highly contaminated sediments should be routinely dredged before and placed in CDFs prior to less contaminated sediments in Great Lakes dredging projects.

m. Remedial action plans that were developed to clean up "areas of concern" identified by the International Joint Commission should be implemented by appropriate authorities to improve Great Lakes water quality and decrease the number of harbors with sediment requiring confinement.

n. The CE should closely coordinate cost-sharing requirements among participating agencies to ensure that necessary budgeting arrangements can be made to allow beneficial uses of dredged material to occur.

## CONCLUSIONS AND OBSERVATIONS: WHERE DO WE GO FROM HERE?

### THE US ARMY CORPS OF ENGINEERS PERSPECTIVE

David B. Mathis
Dredging Division, Office, Chief of Engineers
Washington, DC

I welcome the opportunity to provide some closing thoughts on the workshop and on anticipated future directions. I know that Jesse Pheiffer has personally had great interest in the beneficial uses concept and its potential, and he has been quite instrumental in successfully moving several highly innovative beneficial use concepts forward within the CE to a demonstration project stage. He deeply regrets not being able to participate in this workshop, and I am going to pass on some of his and my own thoughts as to where we go from here in the CE.

My boss, Bill Murden, is scheduled to provide some closing remarks in a few minutes which will focus on the conclusions and his observations on behalf of the CE. I will direct my remarks to providing one point of view on where we go from here, specifically from the standpoint of program management, future applications, and implementation of the beneficial uses concept within our national dredging program.

I would like to first address some near-term directions and approaches and then to address some of the long-term potential applications and methods of implementation. One of the CE basic objectives in this and other workshops has been to raise general public awareness and recognition of the beneficial uses concept as an opportunity with great promise in resource management, and not just another one of those CE tactics of which people accuse us. While we certainly don't want to wear out our welcome by overdoing this type of workshop, our office will continue to encourage and support such regional information exchange initiatives and promising, innovative new beneficial use ideas that will no doubt continue to surface throughout North America over time.

On a related front, many here have expressed a legitimate and frequently encountered concern about the additional and often significant costs of beneficial use alternatives when compared to more traditional methods of dredging and disposal. The CE has invested well over $100,000,000 in dredging-related research and development relating primarily to the environmental effects of such activities. While this long-term and indeed continuing high priority on the environmental side is unquestionably justified and has paid for itself many times over in benefits to the American public, I am happy to inform you of a recently approved new R&D initiative similar in scope and size to the 5-year Dredged Material Research Program (DMRP) which we completed in 1978. This new dredging R&D program will specifically focus on ways to significantly improve the efficiency of the dredging operation as well as dredging management. I anticipate that this initiative will have a number of environmental benefit spin-offs such as achieving greater cost efficiency in applying the beneficial uses concept.

Secretary Doyle, in his keynote address, made note of an early finding of our joint initiative on coastal habitat development with the National Marine Fisheries Service (NMFS). This was that the beneficial uses alternative had simply not been fully considered in many cases by the CE in our project evaluations prior to beginning this initiative. He also stated that our final revisions to the environmental compliance regulation for Federal dredging projects would require full and equal consideration of the beneficial uses alternative. The proposed final regulation revision was sent to his office about 2 weeks ago, and if all goes well, should be published in late November or shortly thereafter. This comes at a time when the politicians are in the process of effecting another round of remedies for the Federal deficit. This will no doubt mean additional cuts in our maintenance-dredging budget which for several years now has been faced with many more active maintenance-dredging projects (about 250) than we have funds to accomplish. This will continue to require tough decisions within the CE as to dredging priorities and very close scrutiny of each project and its continuing economic viability.

Of particular concern are a number of small yet very worthwhile navigation projects around the US which serve small fishing, timbering communities, and other regional economics that are experiencing severe and chronic economic depression. The beneficial uses concept is of particular interest to us in these cases. One recent example is the oyster habitat creation project in the Chesapeake Bay involving a 5-ft channel that serves a US Coast Guard station and a regional fishing fleet. The State of Maryland conservatively estimates that if the habitat effort is only marginally successful, the benefits in terms of increased oyster production will exceed the dredging costs within 3 years for a project dredging cycle of 5 to 7 years. Our perspective at this time is that such attendant benefits should be appropriately added to the benefit side of the benefit-to-cost ratio for these projects, and I am personally unaware of any existing constraints to such an approach.

From a long-term perspective, the bottom line in beneficial uses application is rather fuzzy at present, but I think that the general direction, at least in my own mind, is fairly clear. We in the CE do not in any way perceive the beneficial uses concept as a panacea for our dredging program, and I am hopeful that we have not given an impression to the contrary. We have a number of policy, procedural, and legal issues to sort out over the next several years. The speakers this week have identified several significant policy and procedural roadblocks which are being encountered nationwide in efforts to apply this concept. No doubt others will surface as we continue to gain practical experience with beneficial use applications. The cost-sharing requirements of the WRDA have created a totally new ballgame for the CE, and it will take considerable time and no doubt, some raw pain, before full implementation of this new management direction is effected. While Congress's increasing recognition of the beneficial uses concept is quite encouraging, as evidenced by the varied provisions in the WRDA, Congress has a notoriously poor track record at attempting to play scientist. It will take some time to fully evaluate the practicability and technical feasibility of some of these beneficial uses provisions and how they will ultimately be implemented, particularly in terms of their cost-sharing requirements.

Also in the realm of long-term application and implementation is the recent national CE initiative to develop an appropriate technical framework

and policy guidance for implementing Long-Term Disposal Management Strategies (LTMS). We view the beneficial uses concept as being most appropriately and effectively applied within the context of this broader management framework and perspective.

We fully recognize that early and continuing resource agency and public coordination is essential if this LTMS concept is to be at all effective. However, the common denominator for all is resource management, and the overall objective is wise and balanced resource use and conservation. Some of the major areas of anticipated focus are: (a) maximizing cost efficiency in concept development (we have 250 projects); (b) who pays and how; (c) appropriate and reasonable resource management units; (d) reasonable and appropriate management objectives to include critical resources and habitats; (e) pulling together the collective lessons learned with this concept to date; and (f) effective LTMS implementation. The latter is an area with considerable room for innovation to include consideration of such concepts as Special Area Management Plans, both for development related to intended project benefits as well as for conservation. It also includes such regulatory considerations as long-term regional permits and technical issues such as sediment testing and evaluation procedures.

The Upper Mississippi River initiative (GREAT), evidenced by many during the workshop field trip, is an excellent case in point of what can be accomplished in this area, and each participating agency is to be fully commended. The value is not necessarily as a "how-to" model since this effort involved considerable time and expense. The extremely important point, however, is that this Upper Mississippi River effort clearly demonstrates that it can be done and done very effectively. We certainly hope that we can take full advantage of the many lessons learned during the GREAT evolution to develop effective "how-to" guidance for applying the LTMS concept within our national dredging program.

One final area is the ongoing coastal habitat development initiative between the CE and the NMFS. A major underlying objective of this initiative is to identify to what extent coastal habitat creation and restoration can be effected within our existing Federal authorities. This ongoing initiative has potentially much broader application in that it will serve to identify and communicate to all concerned the existing constraints and fragmented resource management responsibilities. In many cases, these fragmented responsibilities and constraints result from the long-standing Congressional practice of purposefully building numerous checks and balances into national legislation.

I am hopeful that over the next 3 to 5 years we can start pulling some of these major pieces of the puzzle together and can collectively see our way clear in dredging and dredged material placement and management as to where we have been and where we need to go. This is especially critical in resource management. It is also essential so that we can better define the most appropriate and efficient application of the beneficial uses concept.

## CONCLUSIONS AND OBSERVATIONS: WHERE DO WE GO FROM HERE?

### BENEFICIAL USES INITIATIVE PERSPECTIVES

John P. Wolflin
Supervisor, Boise Field Office
US Fish and Wildlife Service
Boise, Idaho

Thank you, Larry, for that nice introduction. I participated in the GREAT (Great River Environmental Action Team) Program from 1974-1980, and yes, I would do it all over again without question. GREAT was a worthwhile effort from which a lot of people recognized beneficial uses---not only accommodating the work on the river in dredging projects but also the protecting and enhancing of natural resource values. The camaraderie that developed among the various Federal and State agencies in the Upper Mississippi River (UMR) was likewise a benefit that supports today's management actions.

It is quite gratifying for me to be here. A lot of what we have seen during this workshop has been a result of the GREAT work, and it is a joy to see the progress that has been made. It is also a pleasure to see that the effort has spread out to other parts of the country. We have been trying to develop our own version of GREAT in the Pacific Northwest, for example.

I have tried to capture some of the perspectives I have gained this week and want to present these to you now to stimulate further discussion and action.

Perspective 1: Accentuate the Positive. This was a major theme in the workshop. The purpose and the theme was to change the perception of dredging from negative to positive---to change the terminology from "spoil" and "disposal site" to "placement site" or "relocation area." Quite frankly, I think we can do even better than that. If we are serious about putting the issue of dredging on a more positive note, I suggest that we dub the terminology "beneficial use material" and "beneficial use site." BUM and BUS, if you will!

As was brought up earlier in the week, the stated goal of the CE at the Washington, DC, level is to make beneficial uses a prime objective of dredging operation activities. Bill Murden, Chief of the CE's Dredging Division, has stated a desire that every dredging operation should have a beneficial use for the dredged material. From what we have seen and heard about the UMR and elsewhere, giant steps have been taken in identifying beneficial uses for dredged material. To name a few: on the UMR; highway construction to road sanding from the Twin Cities to Wabasha; and the 4,000-acre Weaver Bottoms marsh rehabilitation project. Quite phenomenal! Road maintenance and ice control in Missouri where demand is greater than the Rock Island District can meet are other beneficial uses. COL Nelson of the St. Paul District estimates that most of the dredged material in his District goes for beneficial uses. This is certainly accentuating the positive!

Perspective 2: What is a Beneficial Use? Scott Hausmann of the Wisconsin Department of Natural Resources asked that question, and it is a good one. We have heard about several projects this week that have been portrayed as beneficial uses; for example, the Memphis Harbor development and the Vicksburg flood control projects. These projects are, without question, providing economic development in the local area. However, single purpose projects such as these do not consider all public interests. It has been demonstrated that the effects on fish and wildlife from water resource and associated land developments can be mitigated. Such actions consider the public's interest in natural resources.

This type of thinking---serving the public's varied interests---is what I see as the predominant motive behind the CE's beneficial uses initiative. Single purpose project thinking is the primary reason for the negative attitude toward CE dredging work. We have to move away from shortsighted, single purpose projects that present a negative image into the area of BUM and BUS.

There is, by and large, no need to change laws and regulations and agency policies to accommodate new thinking. These are basically in place already. We need to continue the commitment to identify the obvious uses of dredged material and to be innovative in developing projects that will pay multiple benefits and dividends to the public. Where institutional changes are needed, and they have been needed in the past on the UMR, these will come out of interagency meetings such as this one---IF they are frank and open discussions and consider ALL the public's interests and not just special interests.

Perspective 3: The Cost of Doing Business. We have heard much about beneficial uses this week. Of everything I have heard, I think the most important may be that people are now willing to look at sediment brought up out of rivers as a resource. When COL Forrest Gay was District Engineer at St. Paul District, he came up with the innovative idea of selling dredged material and using the proceeds to fund natural resource considerations and values. He also said subsequent to that comment, after talking with CE counsel, that it was legally complicated and highly unlikely to ever occur. Frankly, 15 years ago on the UMR, no one would have believed what has now become a reality---the enormous demand for dredged material. The basis is there for further accomplishment. This could be a viable basis for Congressional action---that is, make it a law that this dredged material resource MUST be used in the public's best interest, including sale of the product.

Perspective 4: The National Workshops on Beneficial Uses. I came to this particular workshop to learn and to take some knowledge back to Idaho, eastern Washington, and the Snake River. As Mike Passmore from Walla Walla District indicated in his presentation earlier in the workshop, we are in the infancy of our efforts on the Lower Snake River. Working groups have been formed, and technical issues are now being examined. The issues are similar but at the same time different from the rest of the country. The sameness is the CE remains responsible for maintaining navigation and flood control. The difference is that on the Lower Snake River there are stocks of anadromous fish that migrate from the Pacific Ocean through our inland rivers to headwater streams to reproduce. Resulting young move down the waterway to live and develop in the ocean before returning to spawn. Some salmon stocks are so

depressed that many scientists believe that they should be protected under the Endangered Species Act.

The low numbers of anadromous fish are directly related to construction of locks and dams on the rivers. This situation is completely different from what the rest of the country deals with on dredging projects. There are scientific questions that need answering. It took us 5 years to come up with answers to scientific questions on the UMR that allowed implementation of the revised channel-maintenance program that has provided for the Weaver Bottoms restoration. Certain scientific issues must be evaluated in the Lower Snake River before we can use the term "beneficial use" for in-water placement of dredged material. There is the potential that scientific investigation may result in determining that for certain locations or times of the year in-water placement may not have an impact. At this point in time, however, open water disposal is simply not acceptable to any of the Federal and State resource agencies because of the sensitive anadromous fish situation.

Several other issues that have been addressed this week require further discussion: confined disposal facilities, cost-sharing---everybody keeps talking about cost-sharing and how it will be implemented---the use of non-native vegetation species in reclamation efforts. These issues could have significant impacts from a fish and wildlife point of view. I hope that we can continue to discuss these issues with open minds.

Finally, this conference has brought together what is being done around the country to deal with existing problems associated with dredging and dredged material placement. We find that the issues are being addressed to varying extents in different areas. We all have the opportunity to pickup on the success stories that have been identified. The best thing we can do is to demonstrate the leadership to do so and to recognize that the public is best served by multipurpose projects that give equal consideration to natural resource attributes. The charge was clear from Mr. Doyle and BG Offringa when they told us to learn, get innovative, take it home, and put it to work. Thank you.

## CONCLUSIONS AND OBSERVATIONS: WHERE DO WE GO FROM HERE?

### A STATE AGENCY PERSPECTIVE

John W. Smith
Missouri Department of Conservation
Columbia, Missouri

I am honored to have been asked to offer some concluding remarks from a state perspective on the all-important question of, "Where do we go from here?" It would be difficult to represent the myriad of issues and opportunities that confront State agencies regarding the beneficial use of dredged material. If I have learned nothing else during the past few days, I've learned that every state has its own perspective on the subject, each with special problems and potential solutions that are often site-specific. Nevertheless, forums such as this allow us to learn from the experiences of others.

I would like to begin by applauding the spirit of cooperation that brought us here in the first place, to discuss this extremely important resource issue. The fact that we are here at all is a tribute to the commitment of our respective agencies to explore long-term solutions to important resource management problems, particularly how we can maximize benefits to the environment while meeting channel maintenance or other objectives in a cost-effective manner.

The CE, in particular, is to be commended for its leadership role in making workshops such as this one possible. Without the interest and support of the CE, it would be impossible to achieve cooperative, mutually beneficial solutions to dredging problems. I can assure you that the Missouri Department of Conservation supports the development of beneficial uses for dredged material, especially those that would enhance fish and wildlife habitat values.

A generality that I believe pertains to all of the State agencies represented here is that we are very interested in long-range planning. Certainly, we need to see plans for proposed engineering structures and other river modifications before they reach the contract stage. Early communication is important. We welcome the opportunity to develop cooperative programs in partnership with other State and Federal agencies, to ensure that the diversity of our aquatic and riparian habitat is maintained or enhanced. During the past few days, we have witnessed firsthand what can be accomplished when a high level of interagency coordination is achieved.

The example provided by the Upper Mississippi River experience serves as a model that could be applied successfully in any geographic region if only we were willing to work hard to achieve it. Each of us should strive to open and maintain the lines of interagency communication that are essential to getting the job done effectively. The bottom line is <u>COOPERATION</u>. Only when we work together to address complex resource issues do we derive full benefit from the array of talents, expertise, and capabilities possessed by each agency. To do

anything less is to accept mediocrity, and in fact, may be considered planning for failure.

I am encouraged by the frank, open discussions that have taken place here regarding the potential for least tern habitat management in the Lower Mississippi River. One of the major benefits of a workshop such as this is to bring people together to discuss mutual problems and opportunities. I am optimistic that the dialog established here will only be the beginning, and that a planning effort will be undertaken to ensure the long-term availability of least tern habitat in our changing river system.

As an added thought regarding the least tern, I would like to suggest that the CE consider the tremendous public relations and species management benefits that would accrue if they would formally embrace the endangered least tern as a featured species for inland waterway management. The featured-species concept could be expanded to include other species as well in regions outside the range of the least tern, such as the bald eagle, canvasback, Canada goose, pallid sturgeon, etc. The long-term survival of the least tern is directly dependent upon effective management of riverine resources. Whenever the opportunity to enhance or create least tern habitat can be integrated with channel maintenance or stabilization objectives, it should be routinely accomplished, and the CE would receive much-deserved credit for the benefits that would follow. I am hopeful that the next generation will view the continued survival of the interior least tern as a symbol of the CE's commitment to multiple-use river resource management.

In addition to finding beneficial uses for dredged material, I believe this workshop has identified a need for the CE to take a closer look at the benefits that would be derived from maintaining dike fields as aquatic habitat. Dr. Drew Miller presented some compelling evidence regarding the value of coarse-grained dredged material to subsurface habitat quality. Drew also indicated that the tremendous value of riprap as a habitat feature generally has been overlooked by the CE. These values certainly extend to the rock placed in dikes, which has been pointed out clearly in numerous studies published by the WES.

I have appreciated the opportunity to meet and get to know many of you during this workshop. On behalf of the Missouri Department of Conservation, I would like to commend and thank the CE for putting together a fine workshop. It has been a pleasure being a part of it.

## CONCLUSIONS AND OBSERVATIONS: WHERE DO WE GO FROM HERE?

## VIEWS FROM THE PRIVATE SECTOR

Laurence R. Jahn, President
Wildlife Management Institute
Washington, DC

Mary Landin asked me to give some views from the private sector. You can appreciate that I will not go back and review points already covered well by previous speakers. However, some perspectives will be added to complement their statements.

First let's return to Weaver Bottoms mainly because that project is tremendously impressive. What I haven't told you previously is that I once examined the Chippewa River, its accelerated sedimentation, and its large load of sediments flowing into Lake Pepin. That was prior to installation of the sediment trap. The accomplishments we viewed on the Weaver Bottoms field trip show what the private sector expects of public organizations and governmental agencies working together. The private sector looks to those agencies as stewards of our lands and waters and to government employees as people dedicated to accomplishing sound resource management, nothing less.

I have been deeply concerned and involved recently with the question of bashing and bad-mouthing good people who are in government service. Paul Volker is chairman of a new commission focusing on government personnel and services. We have met with representatives of that commission. Our objective is to demonstrate that civil servants, such as many of you represented in this room, truly are making a significant contribution to the maintenance of the resource base and to the welfare of society and its continued economic well-being. That is different language from what you will read in the newspapers or hear in some other media. However, some of us are committed to doing everything we can to turn that image and bad-mouthing around and make it more positive just as you are now dealing with terminology in dredging to achieve a more positive approach and response to that activity.

All agencies, regardless of their historic roles, must view themselves as cadres of planners and designers of sensitive resource management, with a responsibility for: (a) preventing degradation of the resource base---this is absolutely essential; and (b) advancing multiple benefits from their activities.

The term "prevention" needs some elaboration. Did you ever stop to think we have had Superfund and now we have a Super Superfund? We have simply enlarged the dollars---taxpayers' dollars, plus some cost-sharing by industry. However, Superfund, and don't ever forget it, is a major restoration effort for past mistakes---improper planning, and insensitive considerations to byproducts from certain activities. That restoration load is contributing to the enlarging budget deficit. Collectively, we can root out and diminish that taxpayer load by ensuring that a strong preventive dimension is incorporated in our plans and actions.

Widely accepted accomplishments by those of you in this room and other civil servants scattered about in State, Federal, and local governmental agencies can help solidify support of the public for well-designed, multiple-benefiting management. This will require the flow of taxpayers' dollars through periodic action by the Congress, State legislatures, county and city boards, and by Parliament in Canada at the Federal and Provincial level. That feedback from the public is very important to help overcome the financial constraints now being encountered.

There is no question that the grassroots support must be enlarged. I want to offer some perspectives on how we may be able to accomplish that. Remember, your achievements, your accomplishments---such as Weaver Bottoms and other areas scattered throughout the US---serve as a feedback loop to provide people with satisfactions. If the public knows this, they will go to bat for the kinds of programs you feel are necessary.

The caution I have for you is not to mislead the private sector. It is costly to do so---very, very costly. I am sure all of you can think of examples of this happening. A number of speakers referred to the Public Trust Doctrine of Law. There should be no misunderstanding in your minds on that critical legal mandate. If we are to continue to have a reasonable economy to provide a reasonable standard of living to the citizens of the US, then we must have a productive resource base to support the economy. The resource base has to be healthy; it has to be productive, and it has to be sustained over time. It is very important to remember needs for the preventive dimension and the time factor---long-term.

In responding to management needs and designing activities, there is no question that we have to make changes for a number of reasons, including incorporating new results from technology. We have to be broad enough in scope and flexible enough in procedure to incorporate those changes. I'll bet some of you in this room, including Bill Murden and myself, can remember when there was no television. We have accepted TV and enjoy football games and other shows. People simply accept change, and hopefully, we can continue to do this on a large scale.

A few examples in agriculture illustrate some changes that are needed. We <u>must</u> have the use of land within tolerable limits of erosion rates. How can we sit back as citizens and as professionals and permit the accelerated erosion rates to continue? I appreciate that use of land is a very sensitive topic. Does an individual really have the right to do as he or she pleases with a piece of property? The courts have responded. Individuals have responded. And the answer is an emphatic "NO!" Why? The resource base is there to use but to use within guidelines and according to standards acceptable to society.

Likewise, with water, we are faced with quantity and quality problems, management challenges, and horrendous restoration costs. Do you ever think about what the Clean Water Act really says? It says, "Correct your past mistakes!" Collectively, as a society, we are responding to correct our past mistakes. However, what we really need is to incorporate that preventive dimension identified previously. Then we can shrink restoration costs.

Games have been played with cost/benefit calculations and procedures. The process, not the individual evaluation, is at fault. We have seen benefits exaggerated, costs minimized, decisions reached, and projects completed in a less-than-sensitive manner. The record shows that we have made and are making some very bad mistakes. The problem is that the economic evaluation procedure has been incomplete and inadequate to reach the best possible decisions.

Another way to express this simply is that there are some values beyond economic expression at the present time. However, don't ever let an economist say that these values are externalities, and permit him to put them in a bag and then throw the bag away! The reason---these values are still in that bag! Despite where the values are located, they must be taken into account, not be set aside just out of reach of the person using the calculation procedures.

The first point is that present economic calculation/assessment procedures are inadequate. Advisory service with the US Department of Agriculture and the Department of Defense has included examining cost/benefit ratios and procedures and confirms those inadequacies. Second, we must recognize those values that are beyond dollar expression, such as groundwater recharge. Does anyone have a good dollar value for an aquifer recharge area? The answer is no. But, some people are struggling to come up with such a value. There are other values of a similar nature involved, but I will not prolong my remarks on them. What is important is to have the values beyond dollar expression firmly in mind.

Another item is that of modifying dredging equipment. Eric Seagren talked about redesigning existing equipment. As he talked, I realized that this is such an important topic that I added to my notes to be sure to emphasize the need for modifying equipment and developing new equipment, as well as plans and capabilities to expand our capacity for using dredged materials to accomplish beneficial uses. The engineering expertise and experience in the CE and dredging industry can generate new ideas on how to propel dredged materials greater distances, how to lift them higher, and how to place them more precisely to accomplish project goals. Equipment can be changed. The car I drive today is quite different from the first car I learned to drive. It is the same with dredging equipment.

What can be said about funding? It is best to realize that a couple of witches move around at this particular time of year (October 31) and occasionally at other times as well. One of them is the Federal deficit. Do you realize that when financial and economist types come to a common denominator in handling this problem, there is just one conclusion? The deficit relative to the gross national product is likened to a small pimple on an elephant! A good number of people believe the US could get rid of that deficit if the political will of the Nation decided to do it.

As taxpayers, we have one of the lowest tax rates in the world. If you want to see a contrast, look at Sweden.

The major point on funding is don't be misled, don't close your mind, regardless of what others say. Use imagination. As John Smith from Missouri can tell you, the State of Missouri is very farsighted. It is one of a small

number of states to strengthen funding resource management programs. In 1976, the citizens of Missouri said "We want our conservation program stronger." They went to a constitutional referendum and ultimately voted and approved 1/8 of 1 percent sales tax. In its initial year, it yielded about 25 million new dollars for some of Missouri's conservation programs. Parks and soil conservation interests in Missouri took notice and said they didn't want to be left out. They justified funding needs with objective information, and the same voters showed their public servants that they believe in what they are doing and want to do. In another referendum, the people voted an additional 1/10 of 1 percent sales tax that today is yielding about another 23 to 25 million new dollars for resource management. That is just one state's experiences.

What made the difference in Missouri? Basic information to justify dollars to strengthen resource management was assembled through studies in the State. Everything was laid out and explained to the citizens of Missouri. And after it was placed on the table for all to see, the people responded with strong support for the new funding initiatives.

Let me leave you with this. Use imagination and don't mislead the private sector. Rather, encompass them, share your thoughts with them, and convince them of needs. If you do, I am positive that they will respond favorably. I have never seen it any other way. In the Dust Bowl era and coming out of the Great Depression, there were many good conservation programs forged, laid on the table, and funded in larger numbers than ever before in the history of this Nation. If you let the people know, keep them informed, and treat them as partners (after all, it's their money), they will work with you.

Finally, let me focus on the question of public education. If you take a look at results from public polls in the US and Canada---nationally, regionally, and locally---the people are providing a strong message. They are extremely interested in natural resources, especially wild living resources, and they want to see sound management programs used. They are willing to pay for good management.

Combine those results with my previous statements on funding and you have a unique time in history from which to move forward. If you were a hard-nosed, bottom-line, for-profits-only businessman, you would give your eye-teeth to have a product that generates so much interest and is in great demand. You have the product---natural resources enhancement services---to sell. The need is to market the services and resource improvements that people want.

You have tremendous stories to tell---such as at the Weaver Bottoms---that must be packaged. I suggest that the CE consider making a 30-minute TV documentary on beneficial uses of dredged material for broadcast in Canada and the US. Take your success stories from your experiences, and use your expertise to tell the public about your dredging needs for navigation, national defense, and flood control. Tell in a national TV documentary what you have done and can do with dredged materials for the good of society. You have excellent examples. That outreach and private sector feedback loop would help you in your project work and with your funding needs. One of the best response-oriented programs on TV today is NATURE. Those programs respond

directly to public requests for information and receive very high ratings and tremendous viewer financial support. Take what you have accomplished on handling dredged materials constructively and let the public know of these achievements and the potential for others.

CLOSING REMARKS AND FAREWELL

William R. Murden, Chief
Dredging Division, Office, Chief of Engineers
Washington, DC

On behalf of all of the participants and attendees, I want to express our appreciation for the outstanding and pleasant leadership displayed by the Workshop Moderator, Dr. Laurence R. Jahn. One of the essential components of an interagency and interdisciplinary workshop such as this one is the availability and willingness of a highly respected person who can lead us without partiality and with considerable skill through panels and technical sessions, field trips and high level addresses, to positive and concrete conclusions. Dr. Jahn fulfills these criteria and more. Larry has been generous with his introductions of session chairpersons and others, and it is appropriate that the proceedings of this workshop include some reference to his credentials and experience. There are many---three degrees from the University of Wisconsin in wildlife ecology and management, authorship of numerous technical papers and reports, editor and publisher of numerous outstanding books on wildlife ecology and management, officer in numerous national and international organizations, chairman of the North American Wildlife and Natural Resources Conference, chairman of the Chief of Engineers' Environmental Advisory Board, and President of the highly prestigious, internationally renowned Wildlife Management Institute in Washington, DC. Dr. Jahn's credentials are very impressive, but they do not exceed his enthusiasm nor his gentlemanly demeanor. It has been our good fortune to have had such a leader for our workshop and to have been able to work with Dr. Jahn through his advisory capacity.

I am delighted to see this workshop, dedicated to the beneficial uses of dredged material in inland waterways, so well attended and the interest in this very important topic that has been shown by the variety of agencies and groups present. There have been a wide variety of beneficial applications presented here that were entirely new to me and to others in the audience.

We intend to see to it that the entire workshop proceedings are published and available for distribution to everyone who has an interest in navigation and in riverine resources. As I mentioned during the Federal agency viewpoints panel, there are numerous success stories which need to be compiled and made available to the Federal, State, and local engineering, scientific, and environmental communities as well as to the public at large. So, in addition to contributing to the success of this workshop, you folks have made a significant contribution to the technical literature and to the advancement of the state-of-the-art in both the dredging and the environmental fields.

I was pleasantly surprised and delighted with the summaries from the informal working groups that were presented this morning. You had such a small amount of time last night to come up with some great recommendations from your topic area that I can tell that all of you have been thinking about ways to improve and to move forward in the beneficial uses area for quite a while. Your recommendations will form the basis for planning the next

workshop and will be very useful in managing the national dredging program. I can assure you that the CE will be looking at your recommendations very closely.

In addition to the thoughtful and important findings and conclusions developed during your informal sessions, let me propose yet another resolution for adoption. If you agree, let the record show that the use of the words "spoil" and "disposal" be banned from usage in relationship to dredging operations and the relocation or placement of dredged material unless the material is highly contaminated! Habits are difficult to change, but if we concentrate on changing our own, then we can lead the way toward the use of more accurate and certainly more positive terminology. This alone would be an important contribution of this workshop!

My compliments to Dr. Jahn, Dr. Mary Landin, and to the members of the Coordinating and Planning Committee. St. Paul is an excellent location; the weather has been favorable; and the people of the area warm and hospitable to all of us. Furthermore, the wide variety of technical topics, the geographical distribution of the beneficial use applications, and the fact that the technical papers have been presented by authors representing Federal, State, and local agencies, consulting firms, universities, and port authorities are all major factors contributing to this workshop's importance.

There are several items that we in the CE could consider in planning for the next national workshop on the beneficial uses of dredged material. We need to expand our invitations to include additional co-sponsors. I am pleased that this workshop included representatives from the EPA, the FWS, and the SCS as well as State agencies such as Departments of Transportation and Departments of Natural Resources. I was also pleased that an officer of the non-profit Western Dredging Association participated and that Harry Cook, President of the National Waterways Conference in Washington, served as a session chairman.

However, we should expand our horizons. In addition to the above, I would like to see representatives of the US Navy with their enormous Homeporting Program plans, the US Coast Guard who place the buoys and alter navigation aids, the American Association of Port Authorities, the American Waterway Operators, the National Waterways Foundation, the US Forest Service, and the NMFS (they have been included in all coastal workshops) involved, as well as all other agencies and organizations interested in the water resources of our nation. It is very important that we find a way to increase the representation of the various State agencies as well since they play a very key role in the CE's ability to manage the Nation's waterway systems.

From a planning point of view, it seems to me that the next national workshop should be at a West Coast location and be co-sponsored by the North Pacific and South Pacific CE Divisions. It also seems to me that we should address coastal and maritime activities as technical topics as well as inland rivers and lakes. There are a sufficient number of existing and potential beneficial use applications that are applicable to both coastal and inland waterway activities to justify such a broad-topic agenda. In this regard, we should initiate our planning for the next meeting right away so that we can make information available to everyone as to location and dates as soon as

possible. Dr. Mary Landin, I will appreciate you and your colleagues at WES taking on this task.

I cannot conclude my final remarks without thanking my old friend Bill Goetz, his staff, and his colleagues in the St. Paul District and the North Central Division for their outstanding contributions to the success of this workshop. It could not have been done without you.

It has been a pleasure to be a part of this workshop. I am convinced that your efforts will be a major contribution to expanding the beneficial uses of dredged material and that your efforts will result in projects which meet or exceed environmental criteria while at the same time remaining economically feasible. At our next meeting, I will be "Bill Murden, Private Citizen," but I am looking forward to it and to continuing to work with all of you. Thank you for your attention, and now I will turn the podium back to Dr. Jahn to close our workshop.

PRESENTATION (LANDIN): I would like for you non-CE people to indulge us for a few minutes. I didn't want Bill to get away before we could say this. We have been working with Bill Murden for many years, and a lot of us in this audience are working biologists and engineers who have been involved with dredging research and beneficial uses and related areas for the past 14 years. As a very small token of our appreciation for all he has done for us---his leadership, his guidance, his support---we want to give Bill a photo album of beneficial use sites. There are over 300 photos in the book, and its insert reads:

"Presented to William R. Murden, Chief, Dredging Division, US Army Corps of Engineers, on the occasion of the Inland Waterways Workshop, a national workshop on the beneficial uses of dredged material, 27-30 October 1987, St. Paul, Minnesota."

I also want to emphasize that the album is not complete. We intend to add more beneficial uses photos as time goes by.

MR. MURDEN: My wife Dottie told me that if I got sentimental, she would hit me over the head! So, obviously, I can't afford to get sentimental, but I surely can tell you that for me it has been a very rewarding and very pleasant career. I leave with no regrets. I know that you will pursue beneficial use opportunities and do them as well or better than we have already done. Thank you very much.

# APPENDIX A: FIELD TRIP

Robert Whiting, Daniel Krumholz, Marc Krumholz, and Dennis Anderson
US Army Engineer District, St. Paul
St. Paul, Minnesota and Fountain City, Wisconsin

Richard Berry, Refuge Manager
Upper Mississippi River National Wildlife and Fish Refuge
Winona, Minnesota

The following information and maps were assembled to serve as a guide for the workshop field trip. The maps show the areas we will be traveling through with items of interest numbered and referred to in the text following the maps. Points of interest that will be seen from the tour buses are identified by numbered squares, and those that will be viewed from the tour boat are circled.

The buses will depart St. Paul enroute 75 miles to Lake City, MN. At Lake City, we will board the excursion paddlewheeler, the Hiawatha, and ride downstream through Lock and Dam No. 4 at Alma, WI. A hot lunch will be served onboard. The 30-mile boat ride will last about 3.5 hr, and will end at Weaver Bottoms, MN. From there we will return by bus the 100 miles to St. Paul.

Points of interest that we will observe include beneficial-use placement sites, a hydrographic survey operation, a dredged material relocation project, and other 9-ft channel project operations and maintenance activities, including the Weaver Bottoms restoration and channel-maintenance activities. We will also see the location of several projects being accomplished as part of the Upper Mississippi River System Environmental Management Program. This specially authorized program is fully explained in the accompanying brochure. In addition, we will be able to observe migrating swans, ducks, and geese from a new lookout tower constructed by the US Fish and Wildlife Service as part of the Upper Mississippi River National Wildlife and Fish Refuge.

St. Paul CE District personnel will be serving as field guides up and down the river, and FWS refuge personnel will be serving as field guides at Weaver Bottoms. They will be pointing out features and activities and historical areas of interest along the river throughout the field trip.

## Mississippi River 9-Ft Channel Project

DISTANCE: 243.6 miles - head of commercial navigation at Minneapolis, MN (UMRM 857.6) to Guttenberg, IA (UMRM 614.0).

ACRES: Land - 51,600; water surface - 170,700.

CHANNEL DIMENSIONS: Controlling depth - 9 ft, width - 150 to 300 ft.

COMMERCIAL TONNAGE: 21.0 million tons annually.

RECREATION CRAFT LOCKAGES: 130,000 annually.

DREDGING REQUIREMENTS: 1.0 MCY annually; average of 20 sites/year out of 100 historic shoaling locations.

DREDGING AND STRUCTURAL REPAIR EQUIPMENT:

Dredge WILLIAM A. THOMPSON: 20 in. cutterhead pipeline.
Boosterbarge MULLEN
Pipeline: 4,800 ft floating and 2,000 ft shorepipe.

Dredge DUBUQUE: 12 in. cutterhead pipeline.

Derrickbarge HAUSER: 4-cu-yd clamshell bucket.
Cranebarge WADE: 3-cu-yd clamshell bucket.

Contract: Hydraulic and mechanical equipment as needed.

PERSONNEL: 280 FTE's.

FY 1986 FUNDING: $26,000,000

CE FACILITIES:

| | | UMR MILE |
|---|---|---|
| Upper St. Anthony Falls Lock and Dam | Minneapolis, MN | 853.7 |
| Lower St. Anthony Falls Lock and Dam | Minneapolis, MN | 853.4 |
| Lock and Dam 1 (Visitor Center) | Minneapolis, MN | 847.6 |
| Lock and Dam 2 | Hastings, MN | 815.2 |
| Sturgeon Lake Access | Red Wing, MN | 798.5 |
| Lock and Dam 3 | Red Wing, MN | 796.9 |
| Lock and Dam 4 | Alma, WI | 752.8 |
| Lock and Dam 5 | Minn. City, MN | 738.1 |
| Service Base | Fountain City, WI | 733.0 |
| Lock and Dam 5A | Winona, MN | 728.5 |
| Lock and Dam 6 | Trempealeau, WI | 714.3 |
| Lock and Dam 7 | Dresbach, MN | 702.5 |
| Lock and Dam 8 | Genoa, WI | 679.2 |
| Millstone Landing | Genoa, WI | 677.0 |
| Bad Axe Landing | Victory, WI | 675.0 |
| Blackhawk Recreation Area | DeSoto, WI | 671.5 |
| Lock and Dam 9 | Lynxville, WI | 647.9 |

| | | |
|---|---|---|
| Jay's Lake Access | Glenhaven, WI | 622.0 |
| Lock and Dam 10 | Guttenberg, IA | 615.0 |

In management of the 9-ft channel project, the St. Paul CE District views the Mississippi River as a multipurpose resource of national significance, part of a vast ecosystem that must be respected and protected. The river with its navigation channel is a commercial and strategic lifeline vulnerable to disruption without the careful preservation of the natural stream and the lock and dam infrastructure that facilitates transportation. Its reliability now and in the future depends upon a rational balance of use and preservation that requires coordination between the various interests that place demands on it.

Before Congress authorized the construction of the 9-ft channel in 1930, CE activities on the river consisted of building wing dams, dredging, and clearing and snagging to create first a 4.5-ft channel, then a 6-ft channel. However, as barge traffic became more economical, and tonnage grew, the deeper channel was required by commercial interests. Lock and Dam 1 was completed in 1917, and Locks and Dams 2 through 10 were completed in the 1930's. Upper and Lower St. Anthony Falls were completed at Minneapolis in 1959 and 1963. Constant maintenance for reliability, efficiency, and safety is required on these structures which form the "stairway" for navigation. The aging locks and dams from 2 to 10 will undergo major rehabilitation within the next 10 years; Lock and Dam 1 was rehabilitated in 1984.

The Mississippi River's 1.5 million square mile drainage basin included all or part of 31 states and a portion of Canada. In the St. Paul District, which encompasses the headwaters and upper reaches of the river, the Minnesota, St. Croix, Chippewa, and Wisconsin Rivers are among the major tributaries. Each year, these streams introduce tons of sediment into the river---material which the CE must dredge to maintain the 9-ft channel depth. This material must be placed where it will not affect the navigation channel, the natural resources or beauty of the river, or pose a safety threat. On the contrary, the District strives to find economical placement to enhance the natural resources and recreational opportunities or for other beneficial uses.

The river changes character rapidly from one region to another. In the St. Paul District, the channel is fairly narrow until the Minnesota River enters at St. Paul; then the river widens and gradually spreads into a wide floodplain with backwater sloughs and bluffs rising as high as 700 ft above the floodplain. Between the start of the channel in the pool above St. Anthony Falls and St. Paul, the river drops over 100 ft in 7 miles; in the next 200 miles downriver from Pool 2 at St. Paul and Pool 10 at Guttenberg, IA, the District boundary, there is an 80-ft drop.

The primary cargo moving downriver is grain from farms of North and South Dakota, Minnesota, Wisconsin, and Iowa. Beside being one of the greatest food-producing areas in the world, the region tapping into the Mississippi River transportation system boasts vast coal, oil, and gas fields, and deposits of salt and sulfur, which are among the major commodities barged up and down river to meet energy, industrial, and agricultural needs.

Yet, the Mississippi River corridor of the 9-ft channel project is a flyway for game birds, a prolific fish and wildlife habitat---a fragile natural resource that must be treated with consideration. It is a natural attraction for hunters, fishermen, and tourists thrilled by its scenic wonders. It is a natural playground for recreational boating for millions of people who live within easy access.

1. BENEFICIAL USE SITE: Northport--2.15 UMRM 838.2 RB
Owner/user: St. Paul Port Authority and St. Paul Pioneer Press
Type of Use: Landfill for industrial development
Time Period: 1950's to 1979
Quantity: over 500,000 cu yd
Remarks: Dredged material was placed hydraulically, and the property was developed by the Port Authority and later sold to the Pioneer Press newspaper for construction of a printing plant.

2. BENEFICIAL USE SITE: St. Paul Airport--2.14 UMRM 836.8 RB
Owner/user: Metropolitan Airports Commission
Type of Use: Landfill for airport development
Time Period: 1950's to present
Quantity: over 500,000 cu yd
Remarks: Material is placed hydraulically and used as fill for expansion of the runway system and construction of hangars and other buildings.

3. BENEFICIAL USE SITE: Point Douglas--SC.26 UMRM SC 0.5 RB
Owner/user: Washington County, MN
Type of Use: Landfill for recreation development
Time Period: 1978
Quantity: 20,000 cu yd
Remarks: Material was barged from a dredge cut on the St. Croix River and used as fill for developing a small county park at the mouth of the St. Croix.

4. CHIPPEWA RIVER SEDIMENT TRAP: The Chippewa River is one of the largest contributors of sediment into the Upper Mississippi River system. It deposits large volumes of coarse sand into the navigation channel each year. Shoaling can occur very rapidly and without warning, resulting in restricted or hazardous channel conditions for commercial traffic.

Based on the results of mathematical and physical model studies, a sediment trap was dredged at the delta of the Chippewa River to "catch" the material before it could enter the Mississippi River navigation channel. Approximately 470,000 cu yd were removed from the delta in 1984 and 1985 by hydraulic dredge. This material was transferred to a gravel pit in Wabasha, MN, for pit reclamation and other beneficial uses (See No. 22).

To date, the sediment trap has been successful in reducing dredging requirements in the main channel. The delta is now filled again, and plans are to dredge again in spring 1988. If fully successful, this trap will allow the CE to schedule dredging more efficiently and prevent the development of hazardous channel conditions (See sketch).

5. READS LANDING EXCAVATION: The Reads Landing dredge cut, located immediately downstream of the Chippewa River, is considered the most chronic shoaling location in the St. Paul District. Dredged material has historically been deposited on islands adjacent to the navigation channel. In the 1970's, measures were taken to contain the material on old dredged material, but by the 1980's, the disposal area was filled to capacity. Further expansion was not possible because of the adjacent wetlands and State and Federal regulations.

In 1984 and 1985, as a result of long-term planning, 1.3 MCY of material was excavated from the historic placement site by hydraulic dredge and transferred 9,000 feet to a gravel pit in Wabasha, MN, for pit reclamation and other beneficial uses (See No. 22). The excavated placement site will not be used when channel maintenance or sediment trap dredging is required in the future (See sketch).

6. BENEFICIAL USE SITE: Carrels Pit--4.25 UMRM 761.1 RB
Owner/user: Private landowner
Type of Use: Landfill for gravel pit reclamation and potential development
Time Period: 1982
Quantity: 60,000 cu yd
Remarks: Material was "double-pumped" by hydraulic dredge to reach this old gravel pit. The fill returned a portion of the pit to pre-excavation conditions.

7. BIG LAKE/INDIAN SLOUGH RESTORATION: This project is a joint 9-ft channel operations and maintenance and Environmental Management Plan (EMP) activity. Upper Big Lake and Indian Slough are being adversely impacted as a result of past channel maintenance activities and by natural processes. Dredged material has been placed on and between a series of wing dams on the Wisconsin side of the Mississippi River across from Wabasha, MN, and adjacent to Indian Slough. This large sandpile, known as the Crats Island site, became an unnatural funnel that created above average flows into Indian Slough. These high flows are causing bank erosion of Indian Slough and are moving sediment-laden main channel water into Big Lake. This action is creating a sand delta and filling in aquatic habitats of Big Lake. Sedimentation has created shallow water which has stressed the Big Lake fishery in the winter by low dissolved oxygen levels and in the summer by high thermal conditions. As sedimentation proceeds, it continues to degrade aquatic and wetland habitat.

This project's goals are:

a. Maintain and restore flow into the Big Lake backwater complex by creation and restoration of three channels to divert flow into three separate areas within the Big Lake area.

b. Reduce sediment intrusion into Big Lake area by reducing sediment inflow from the main channel either by partial closure of the mouth of Indian Slough or by re-creation of the channel behind Crats Island containment area coupled with partial closure of the mouth of Indian Slough and by reducing sediment intrusion from bank erosion in Indian Slough by flow modification and/or bank stabilization.

c. Enhance the fisheries value of Indian Slough channel(s) by placement of fisheries structures to provide cover and substrate.

8. CRATS ISLAND EXCAVATION: The Crats Island reach of the Upper Mississippi River channel project has historically required frequent dredging with material placed on the adjacent island or the Wisconsin side of the channel. By 1986, this placement site was essentially filled to capacity without expansion into adjacent undisturbed wetlands.

The District evaluated alternatives and determined that the best long-range channel maintenance plan would be to remove dredged material from the historic placement site so that it can be reused for channel dredging. Two privately owned sand/gravel pits at Wabasha were identified as placement sites for the excavated material (See No. 21). The excavation provides the District with an estimated 40-yr dredged material placement plan.

A contract to remove more than one MCY from the site was awarded in the fall, 1986, to L. W. Mattson Company Inc. of Burlington, IA, at a cost of $2,400,000. The dredged material is being excavated and transferred by hydraulic dredge. The pipeline is submerged across the main channel and runs approximately 12,000 ft to the primary placement site. A single land-based booster is being used in the operation. Excavation is progressing at a rate of approximately 20,000 cu yd/day. Projected completion date is mid-November, 1987.

9. BENEFICIAL USE SITE: Ochsner--4.20 UMRM 759.7 RB
Owner/user: Private landowner
Type of Use: Landfill for residential development
Time Period: 1985
Quantity: 45,000 cu yd
Remarks: Dredged material was placed both mechanically and hydraulically and has been used to develop a residential subdivision.

10. BENEFICIAL USE SITE: Wabasha Marina--4.19 UMRM 759.5 RB
Owner/user: Private landowner
Type of Use: Landfill for pit reclamation and potential development
Time Period: 1977-1987
Quantity: 200,000 cu yd
Remarks: Material was placed both mechanically and hydraulically and has been used for development of the marina and for future residential development.

11. TEEPEEOTA POINT PLACEMENT SITE: This is a historic dredged material placement site that has been bermed to prevent encroachment into the surrounding wetlands. Fine-grained material from the adjacent backwater was dredged and placed on the backside of this site to provide a suitable substrate for establishing vegetation on the side slopes of the berm.

12. GRAND ENCAMPMENT PLACEMENT SITE: This is a historic dredged material placement site that has been bermed to prevent encroachment into the surrounding wetlands. Approximately 15,000 cu yd of material was removed from this site in 1986 by a private contractor and put to beneficial use on a construction project in Red Wing, MN.

13. BENEFICIAL USE SITE: Alma Marina--4.02 UMRM 754.0 LB
Owner/user: City of Alma and US Government
Type of Use: Landfill for recreational development and removal for other use (material is available for removal at the present time)
Time Period: 1950's to present
Quantity: More than 250,000 cu yd
Remarks: Material is placed both mechanically and hydraulically and has been used for development of a city recreational complex and stockpiled and removed extensively by Buffalo County, WI, for road maintenance and winter ice control.

14. ISLAND 40 RESTORATION: This project is an EMP activity. Since 1964, approximately 300 ft has eroded off the head of Island 40. The eroded material has been deposited in the adjacent Wiggle Waggle Slough. This has degraded the fishery habitat in the slough and blocked the outlet of the Finger Lakes and Ing's Lake, degrading the fishery habitat in those lakes.

The proposed project would dredge the deposited material from Wiggle Waggle Slough and open up the outlets of the Finger Lakes and Ing's Lake. The dredged material would be placed at the head of Island 40 and riprapped to prevent further erosion. In addition, approximately 1,200 ft of eroding shoreline on the east side of the island adjacent to the navigation channel would be stabilized by reshaping the bank and constructing deflections spaced approximately 25 to 40 ft apart.

The project would halt the erosion of Island 40, restore fishery habitat in Wiggle Waggle Slough, and prevent further degradation of the warm water fishery in the Finger Lakes and Ing's Lake. Shoreline stabilization would prevent the occlusion of downstream side channels, reduce sediment loads into important backwaters, and improve habitat for some species of fish such as smallmouth bass.

15. ISLAND 42 RESTORATION: This project is an EMP activity. Backwater sloughs at Island 42 did not receive adequate water flows from the Mississippi River at normal pool levels. This resulted in stagnation and dissolved oxygen depletion in these waters during late summer and winter. A major limiting factor for ground-nesting waterfowl in the Mississippi River corridor is the lack of adequate nesting cover.

The project, constructed in 1986 and 1987, provided improved water flows to semi-isolated backwaters through installation of a 100-ft-long culvert and a 900-ft-long excavated channel to improve low dissolved oxygen problems in the backwater. In addition, approximately 25,000 cu yd of material were dredged from the backwater to deepen it from 2 to 5 ft. Material excavated for channel construction was sidecast, and the resulting berm was revegetated to provide waterfowl nesting cover. A closure structure with control gates was installed at the entrance of the excavated channel to reduce sediment flow into the backwater during periods of high flow.

The project has increased fresh flows to the backwaters at normal pool levels and improved 95 acres of fish habitat. It is estimated that production of sport fish species in the improved areas will increase by 50- to 75-lbs

acre. Approximately 0.5 acre of waterfowl nesting habitat above normal floodwater levels was created with the establishment of vegetation on the berm.

16. WEST NEWTON PLACEMENT SITE: This is a historic dredged material placement site that has been bermed to prevent encroachment into the surrounding wetlands.

17. FISHER ISLAND PLACEMENT SITE: This is a historic dredged material placement site that has been bermed to prevent encroachment into the surrounding wetlands. It was one of the two borrow areas used as sources of material for the Weaver Bottoms restoration (See No. 19).

18. LOST ISLAND PLACEMENT SITE: This is a historic dredged material placement site that has been bermed to prevent encroachment into the surrounding wetlands. It was one of the two borrow areas used as a source of material for the Weaver Bottoms restoration (See No. 19).

19. BENEFICIAL USE SITE: Weaver Bottoms--5.30 UMRM 744.0 RB
Owner/user: US Government (Upper Mississippi Refuge)
Type of Use: Environmental restoration and enhancement
Time Period: 1986 to present
Quantity: 1,300,000 cu yd
Remarks: A plan has been developed to use dredged material beneficially to restore and maintain the Weaver Bottoms, a 4,000-acre backwater that has deteriorated severely over the past 25 years, in part due to past channel maintenance activities.

The project was conceived during the GREAT study. It is being undertaken by the St. Paul District as an operations and maintenance project. It will provide a long-term channel maintenance plan that will use the dredged material beneficially and also potentially reduce dredging requirements. The estimated cost of conducting channel maintenance according to this plan is anticipated to be $2,500,000 less than if the project were not implemented and upland disposal alternatives had to be developed.

The project involves modification of side channels into Weaver Bottoms and construction of barrier islands in the backwater. Dredged material from two existing disposal sites is being used to accomplish this work. These alternations are intended to improve the habitat of this backwater by reducing flows, sedimentation, and turbidity. The excavated disposal sites will then be reused during channel maintenance operations. The project is being constructed in two phases.

A contract for the first phase was awarded to Robers Dredge Inc. of LaCrosse, WI, at a cost of $3,100,000. Work began in August 1986 and was completed in September 1987. The first phase involved construction of two islands and all of the side channel modifications. Additional islands will be built in Phase Two, which is planned for FY 1991. The dredged material islands and side channel modifications were completed in July 1987. Approximately 1.2 MCY of dredged material was excavated from the historic placement sites to build the Weaver Bottoms and placed on the islands to cover the sandy material with a suitable substrate for establishing vegetation. Seeding and planting to stabilize the areas are scheduled for spring 1988. A number of

the side channel closures have been protected with riprap, and several have been constructed with partial openings to allow a certain amount of flow into the Weaver Bottoms and to allow recreational boat access and fish movement.

The FWS is a cooperating agency on the project. The States of Minnesota and Wisconsin have also participated in development of the project. All interested agencies will participate in the comprehensive monitoring program associated with the project. The project's total cost is estimated at $5,500,000, and it will provide a 40-year dredged material placement plan.

20. WEAVER OBSERVATION TOWER: This observation tower, recently completed by the FWS, overlooks the Weaver Bottoms backwater where observers can view a variety of waterfowl species this time of year, including tundra swans and canvasback ducks. This area is part of the Upper Mississippi River National Wildlife Refuge.

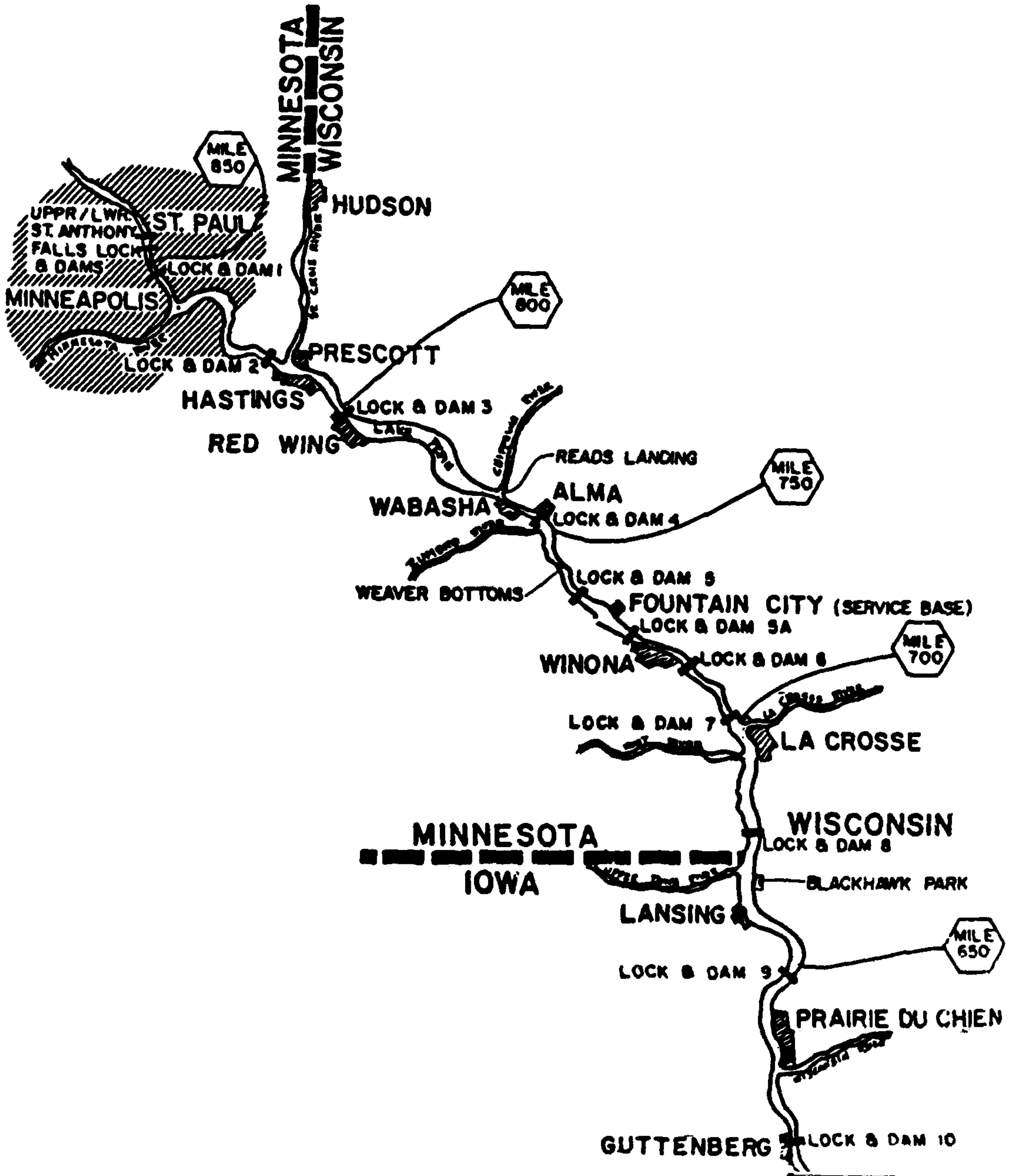
21. BENEFICIAL USE SITE: Wabasha Sand and Gravel UMRM 759.5 RB
Owner/user: Private landowner
Type of Use: Pit reclamation and landfill for commercial development
Time Period: 1987 to present
Quantity: 1,300,000 cu yd
Remarks: Material is being placed hydraulically from excavation of a historic placement site at Crats Island. Plans are to develop the site into a commercial or light industrial use area.

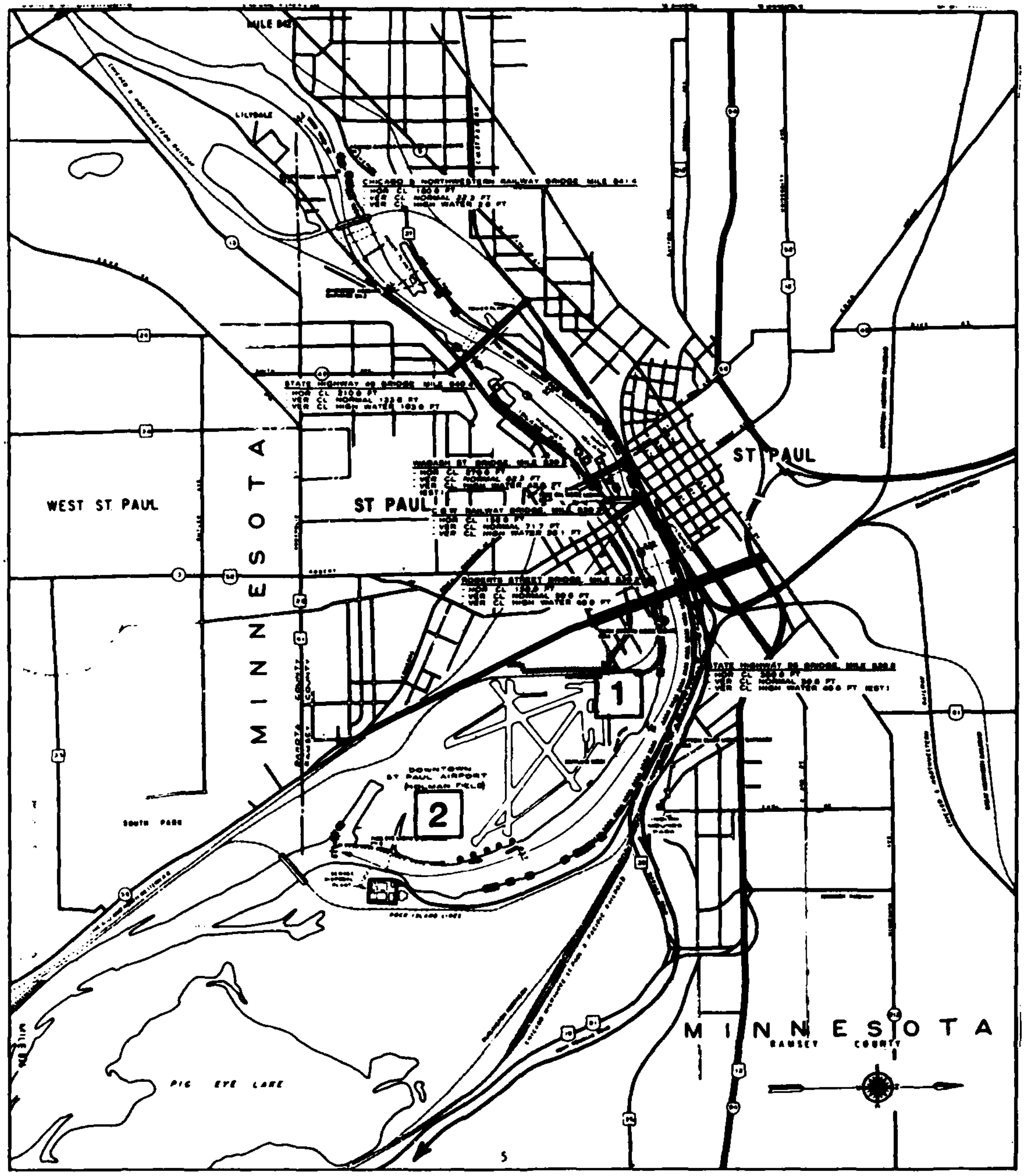
22. BENEFICIAL USE SITE: Wabasha Pit--4.24 UMRM 761.0 RB
Owner/user: US Government
Type of Use: Pit reclamation and stockpile available for removal (material available at the present time)
Time Period: 1984 to present
Quantity: 1,750,000 cu yd
Remarks: This abandoned gravel pit site was acquired by the CE as a long-range placement site for dredging at Reads Landing. Material was placed hydraulically from excavation of a historic placement site and dredging a sediment trap. Material is presently being removed by a contractor working for the Minnesota Department of Transportation on a highway improvement project.

US Army Corps
of Engineers
St. Paul District

# MISSISSIPPI RIVER

# 9-FOOT CHANNEL PROJECT

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ST PAUL
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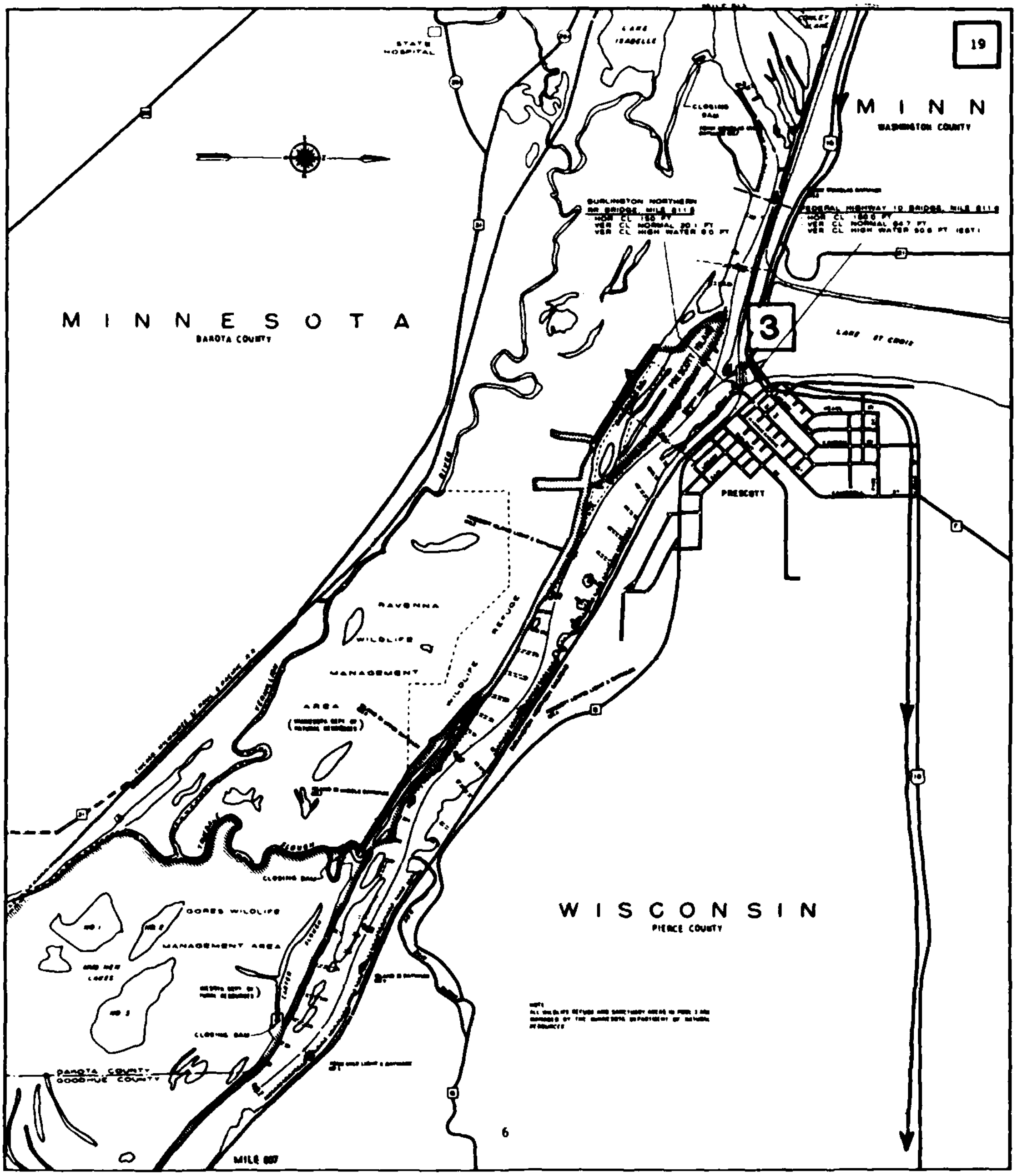
MINNESOTA
RAMSEY COUNTY
DOWNTOWN ST PAUL AIRPORT (HOLMAN FIELD)
PIG EYE LAKE
1
2



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STATE HOSPITAL
M I N N E S O T A
DAKOTA COUNTY
3
PRESCOTT
RAVENNA
WILDLIFE
MANAGEMENT
AREA
WILDLIFE REFUGE
GORES WILDLIFE
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PIERCE COUNTY
DAKOTA COUNTY
GOODHUE COUNTY
MILE 807
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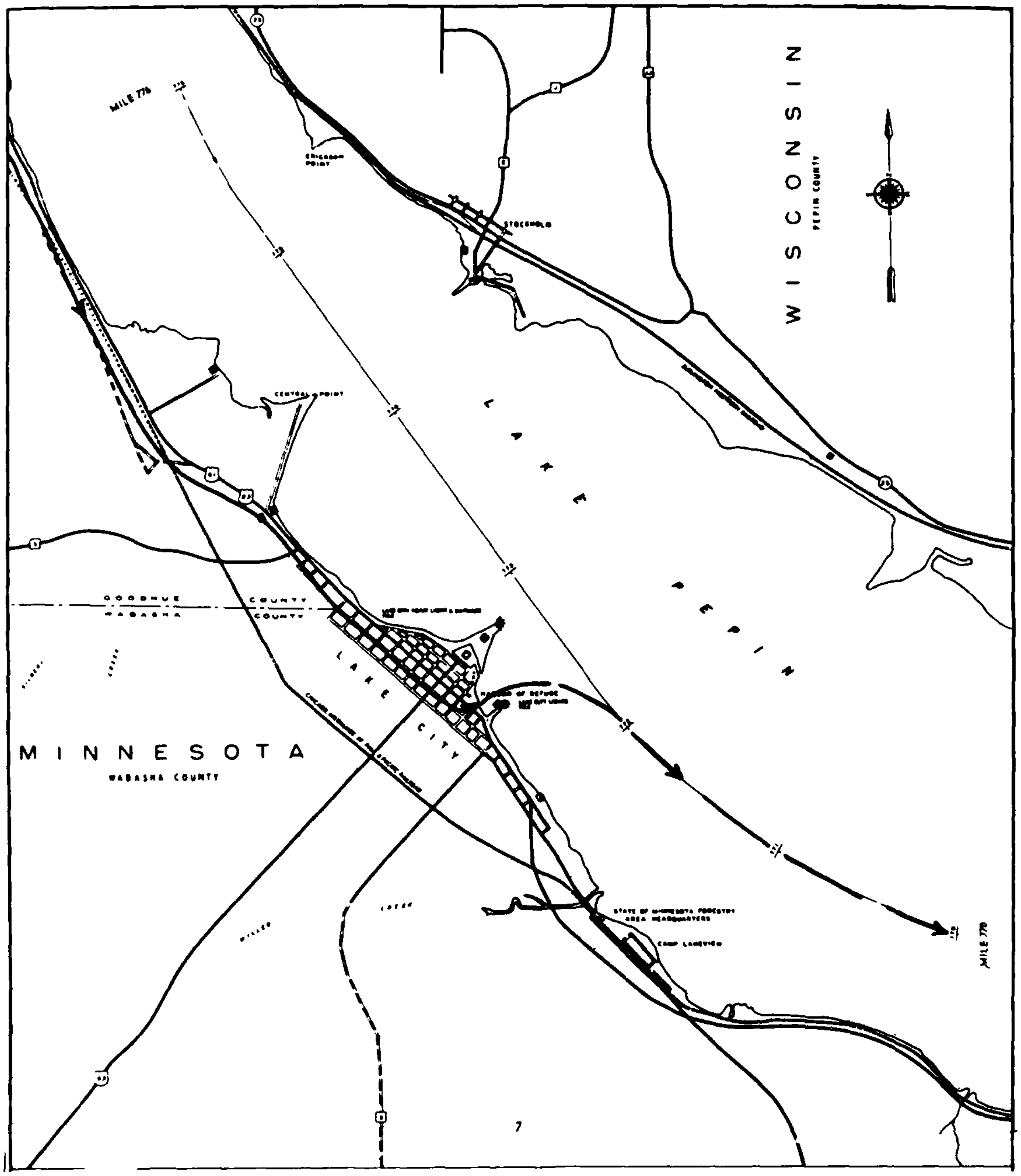
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STOCKHOLM
LAKE PEPIN
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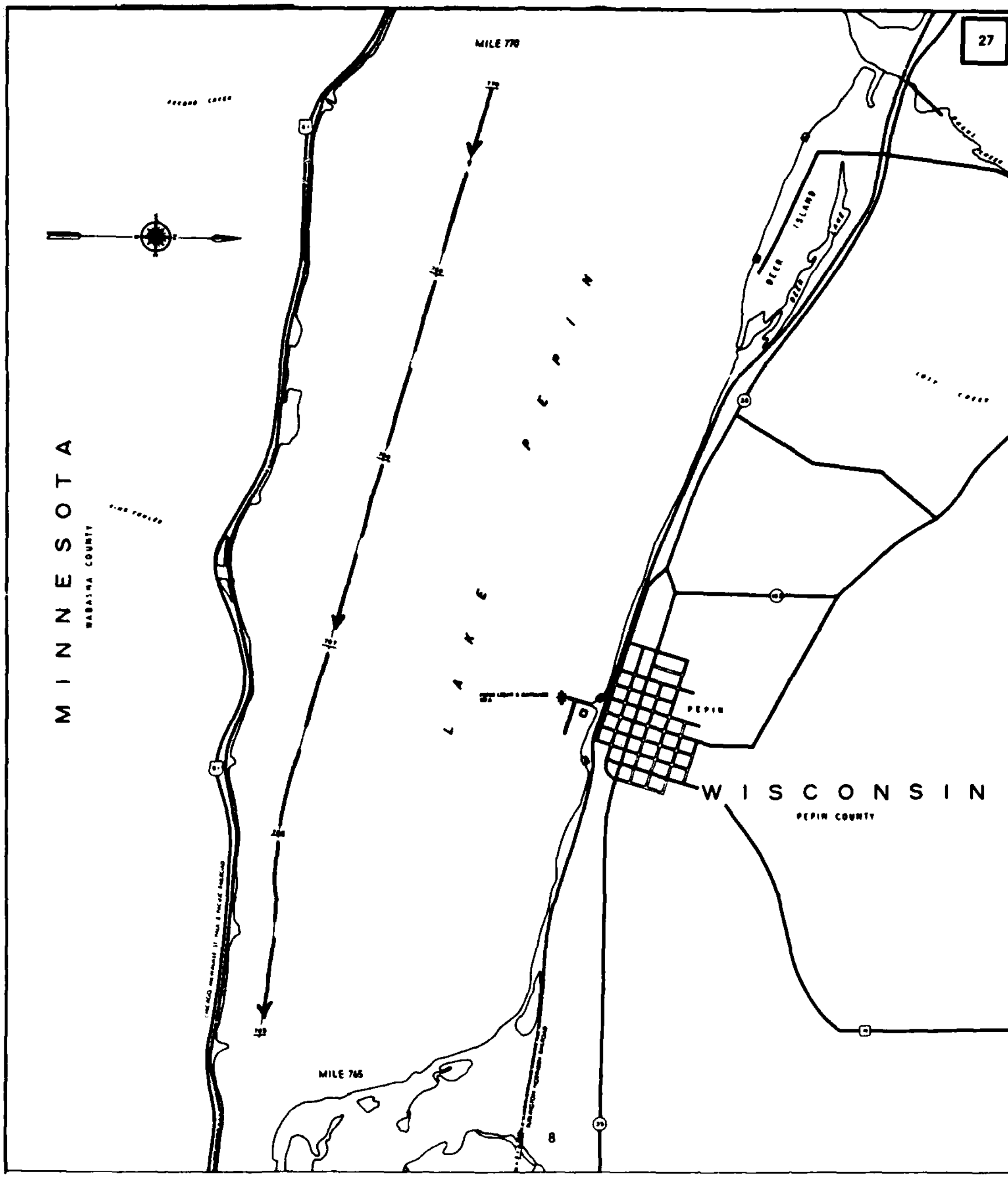
MILE 770
CENTRAL POINT
CAMP LAKEVIEW
7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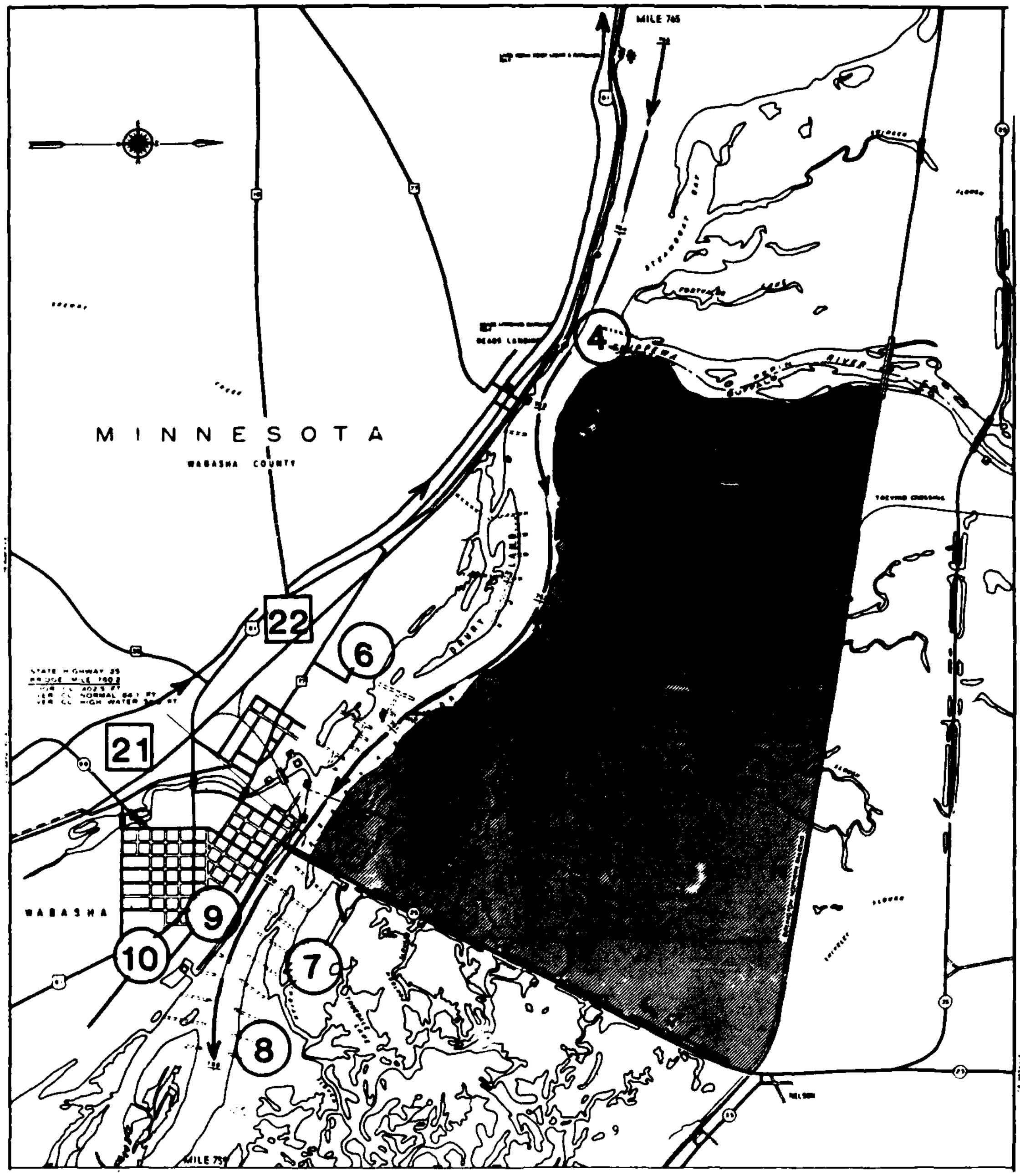

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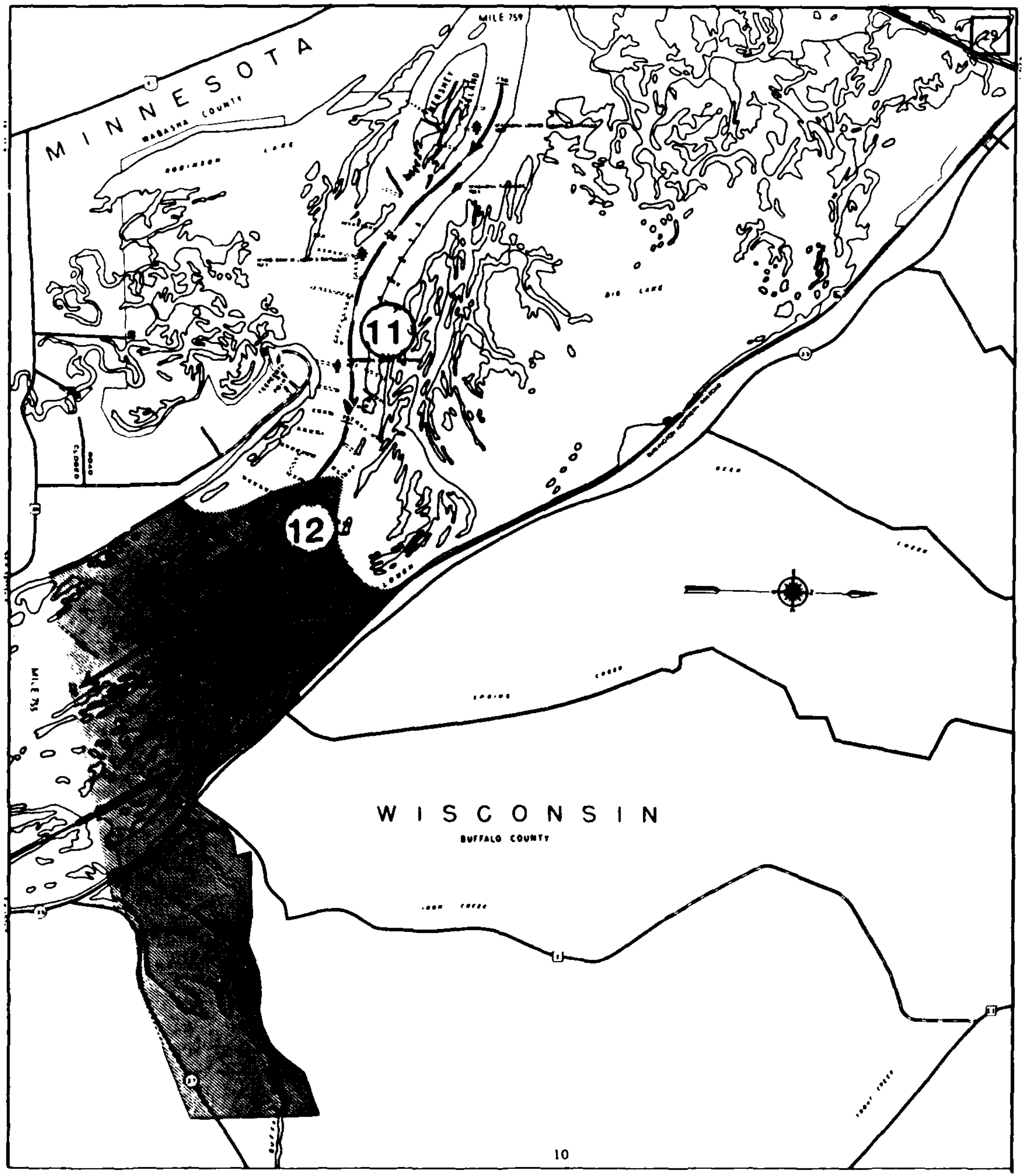

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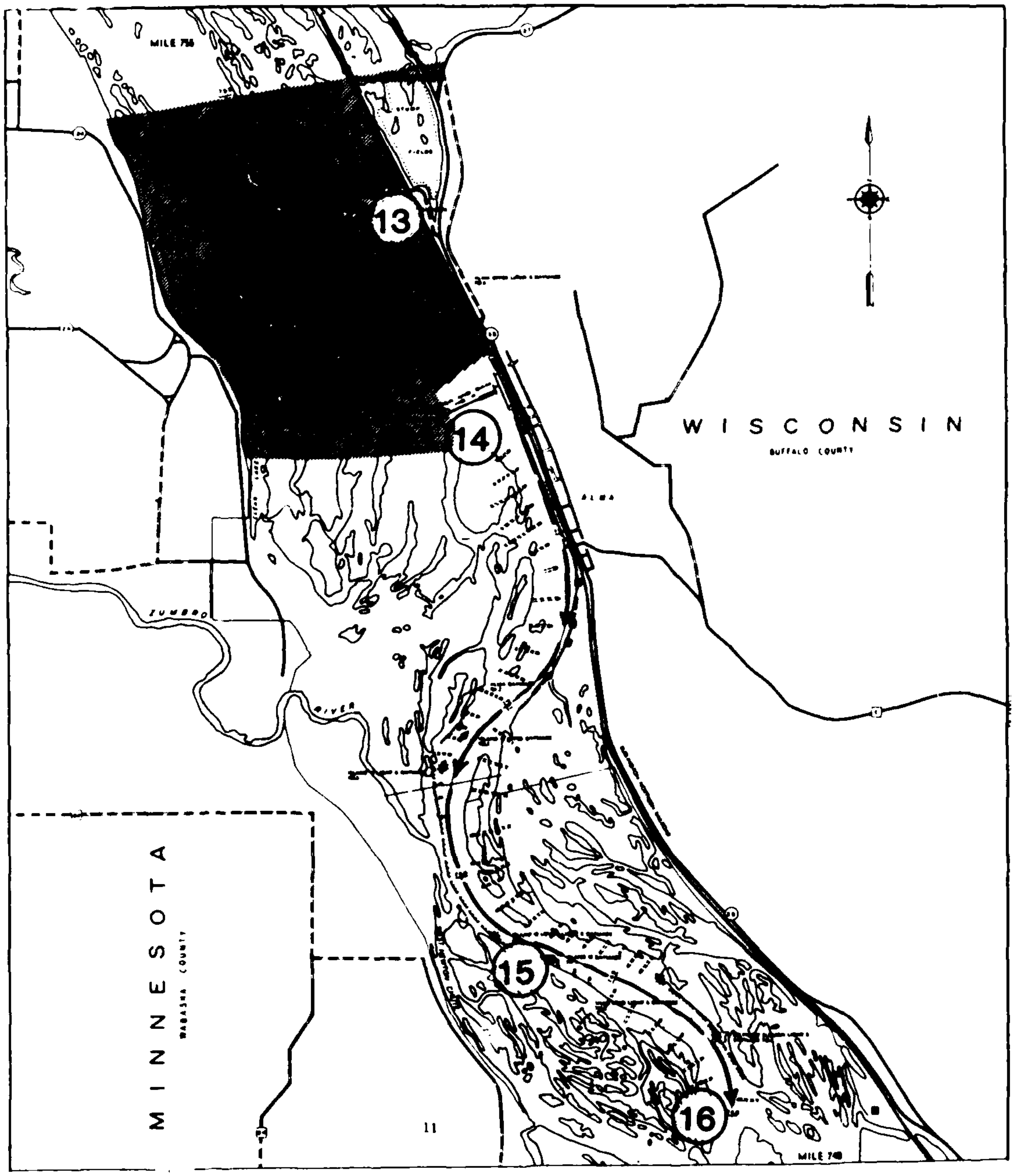
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ALMA
ZUMBRO
RIVER
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WABASHA COUNTY
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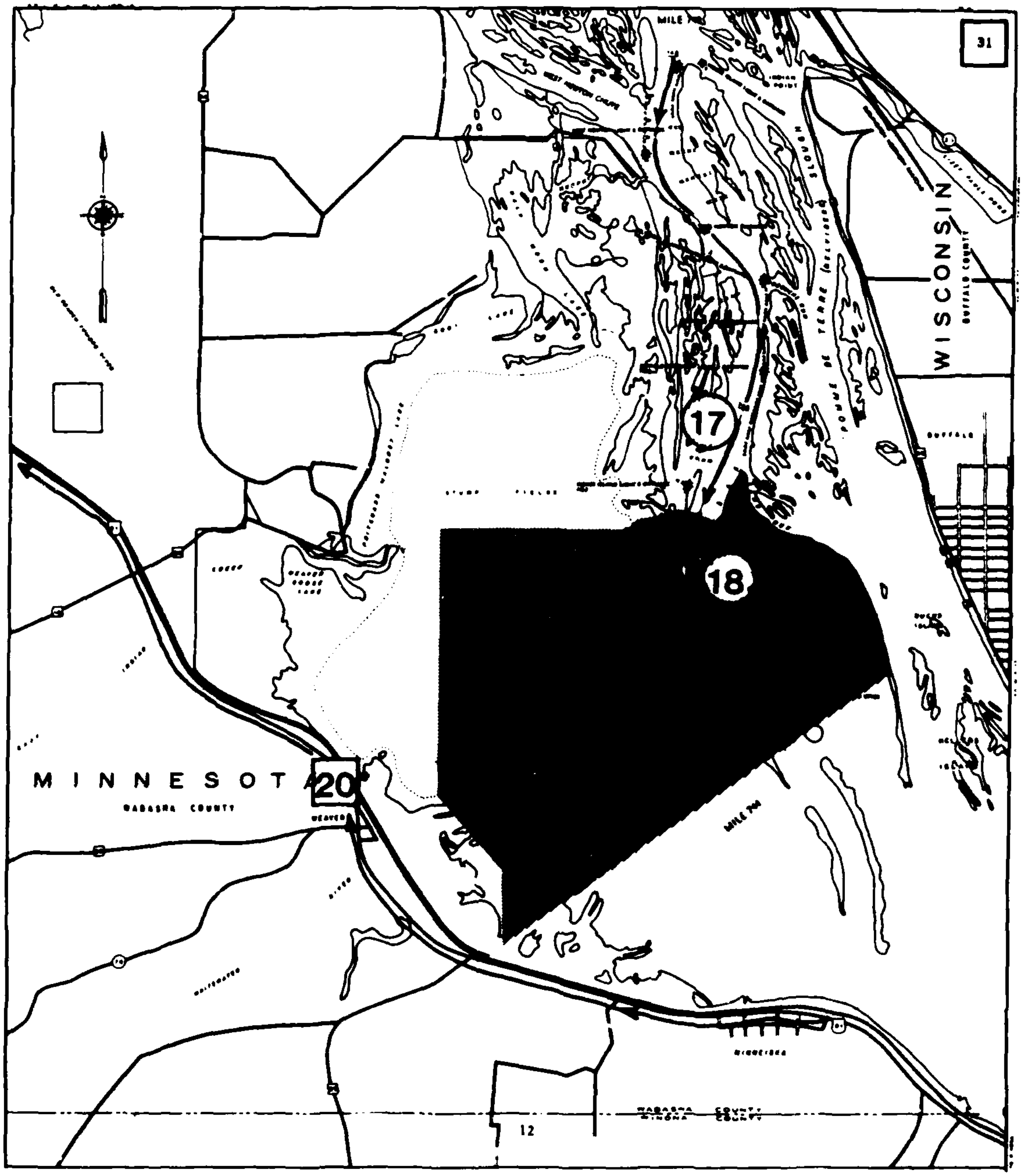
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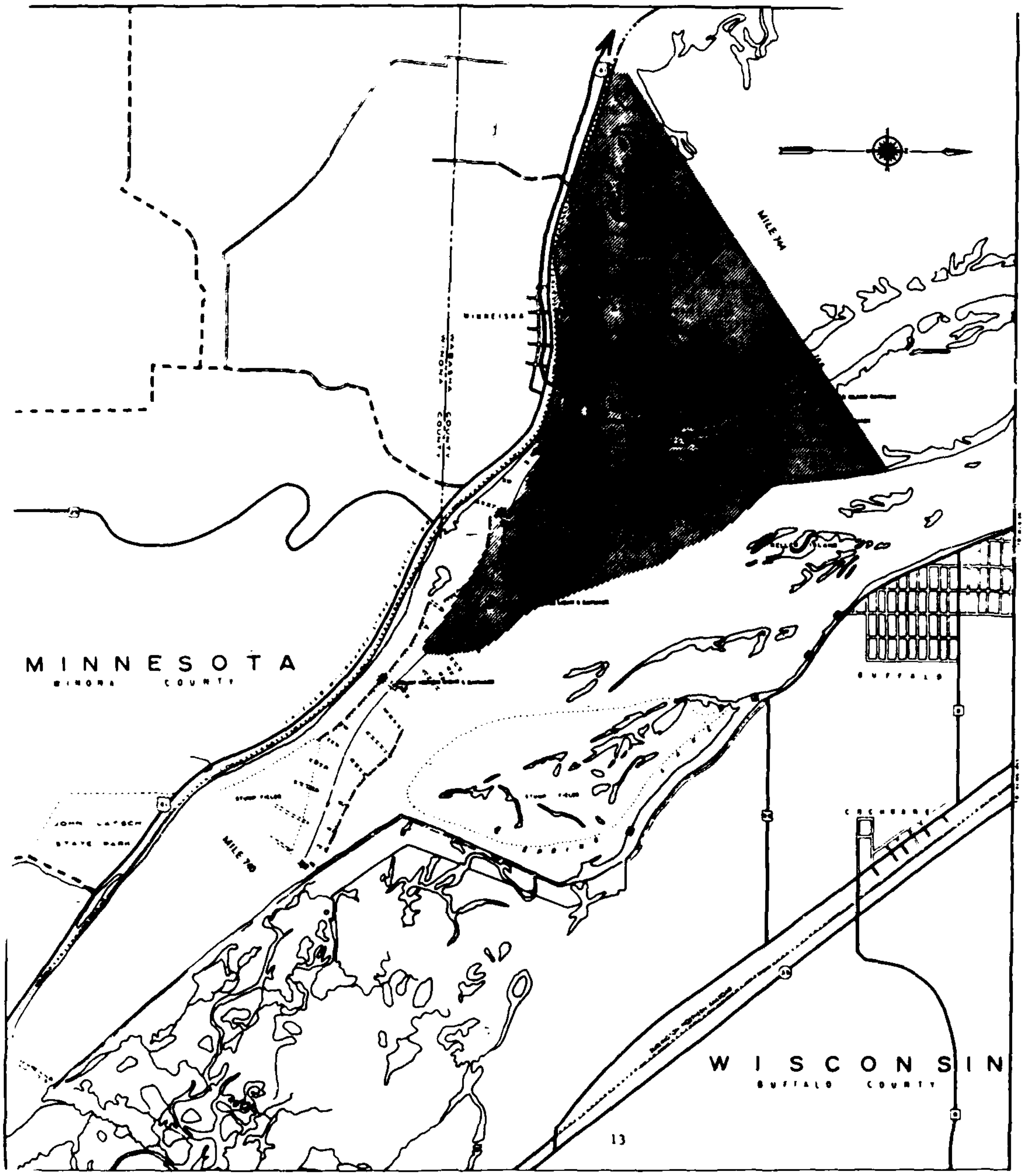
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JOHN LATSCH
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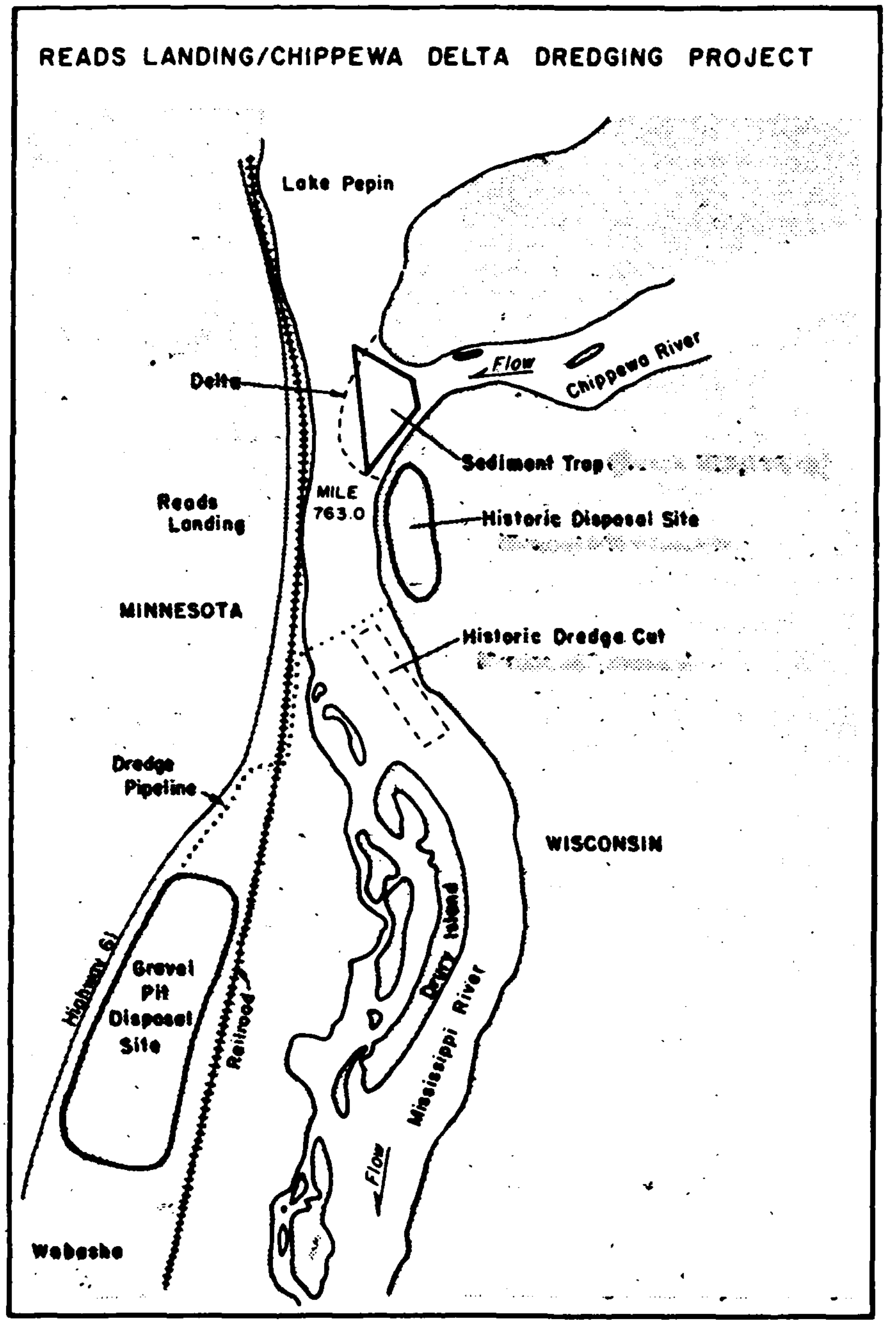
BUFFALO
13


READS LANDING/CHIPPEWA DELTA DREDGING PROJECT
Lake Pepin
Flow
Chippewa River
Delta
Sediment Trap
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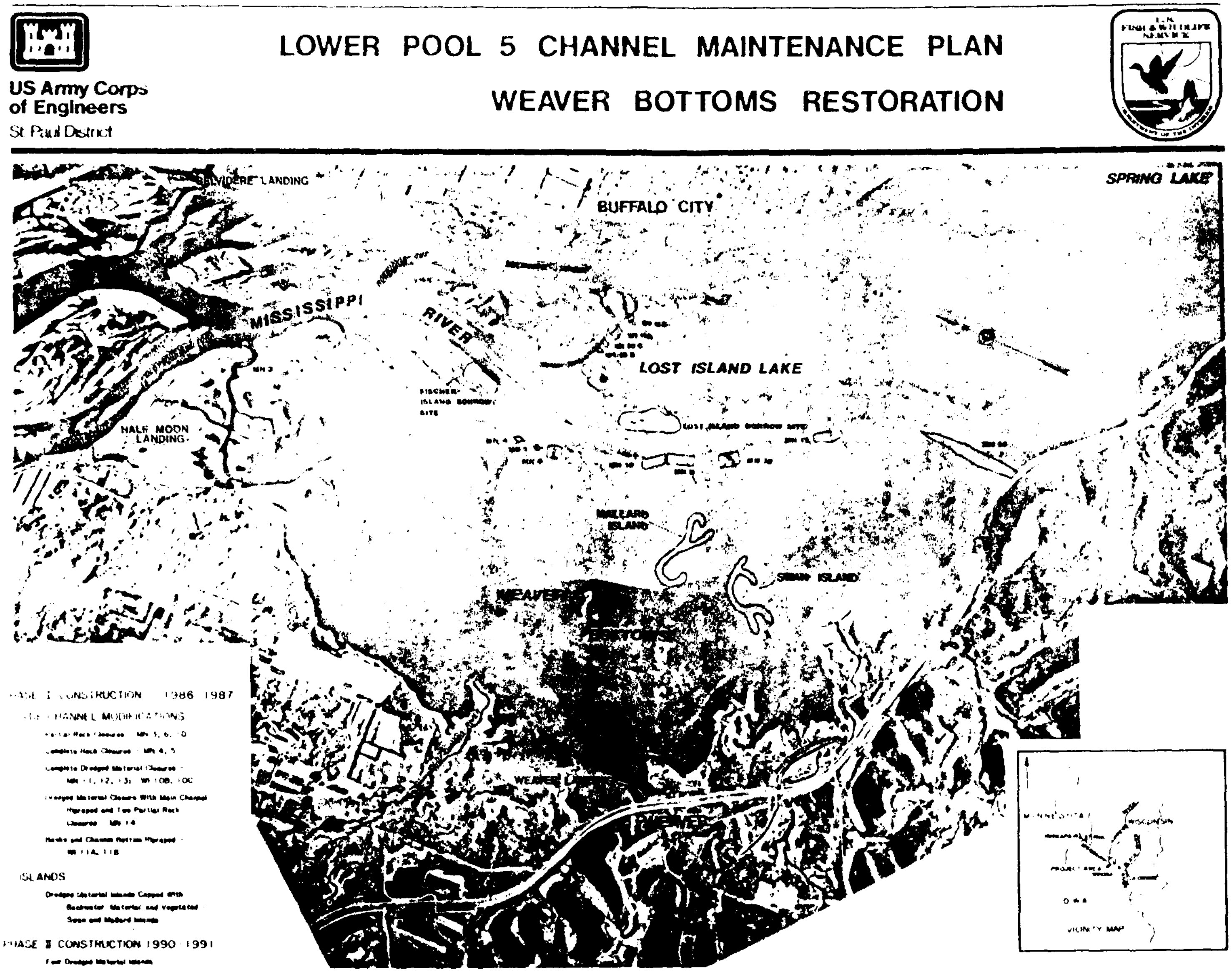
Historic Disposal Site
MINNESOTA
Historic Dredge Cut
Dredge Pipeline
WISCONSIN
Highway 61
Gravel Pit Disposal Site
Railroad
Mississippi River
Flow
Wabasha


US Army Corps
of Engineers
St Paul District
LOWER POOL 5 CHANNEL MAINTENANCE PLAN
WEAVER BOTTOMS RESTORATION
BELVIDERE LANDING
BUFFALO CITY
SPRING LAKE
MISSISSIPPI
RIVER
LOST ISLAND LAKE
HALF MOON LANDING
FISCHER ISLAND BORROW SITE
LOST ISLAND BORROW SITE
MALLARD ISLAND
SWAN ISLAND
PHASE I CONSTRUCTION 1986 1987
CHANNEL MODIFICATIONS
ISLANDS
PHASE II CONSTRUCTION 1990 1991
Four Dredged Material Islands
VICINITY MAP
WISCONSIN